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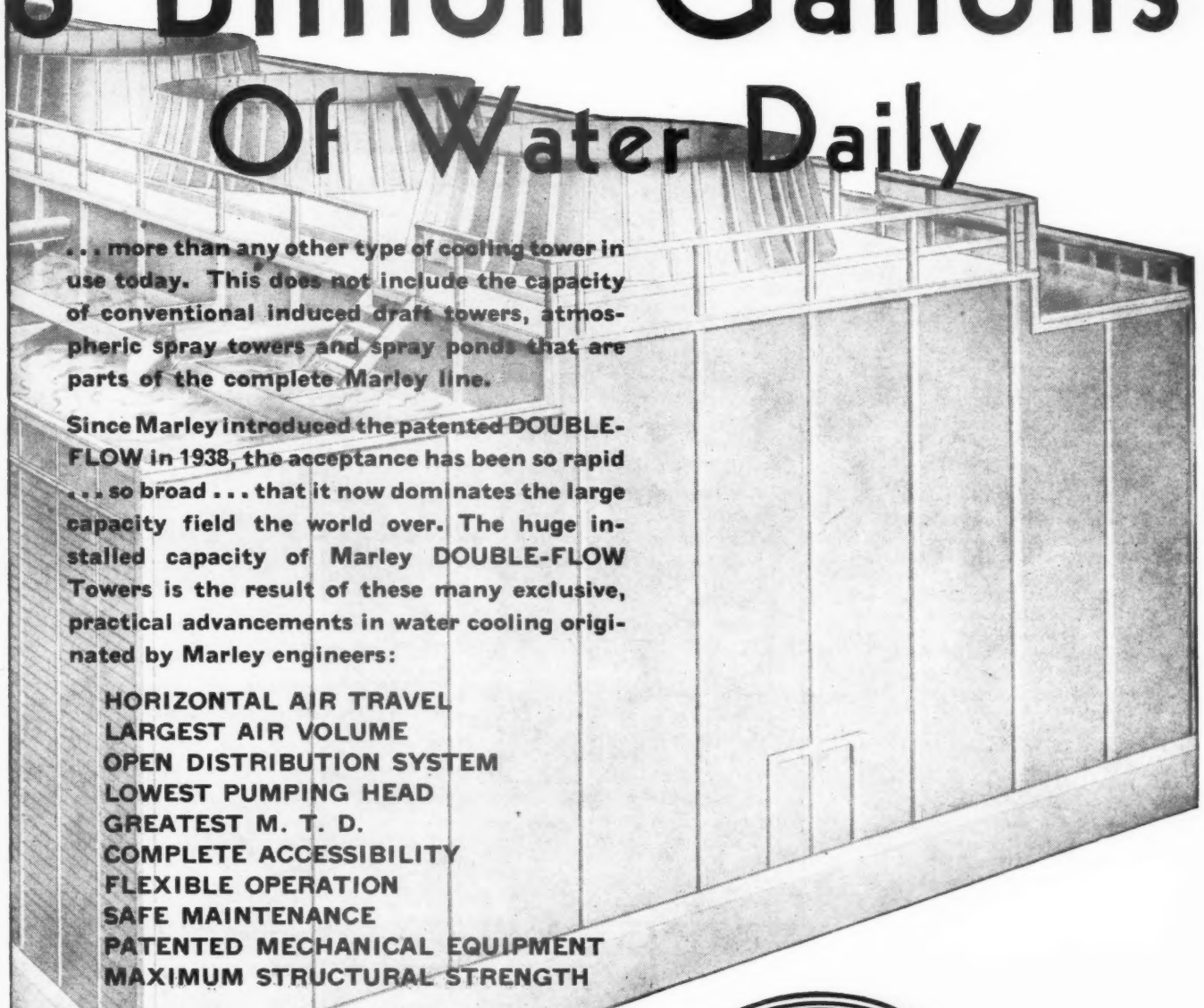

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VOLUME XIX NUMBER 4

the Petroleum Engineer

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MEETINGS

Feb. 15-19—AIME, annual meeting, Pennsylvania Hotel, New York.
Feb. 15-19—AIChE, regional meeting. New Orleans, Louisiana.
Mar. 1—Nomads, Louis Sherry's, 50th St. and Park Ave., New York City.
Mar. 1-5—ASTM, spring meeting, Hotel Statler, Washington, D. C.
Mar. 9—Nomads, The Houston, Tex., Club.
Mar. 9-10—Commercial Chemical Development Assn, annual meet, Roosevelt Hotel, New York.
Mar. 10—Institute of Petroleum, Manson House, 26, Portland Place, London, W. I.
Mar. 10—Nomads, Jonathan Club, Los Angeles, Calif.
Mar 12-14—Texas Independent Producers & Royalty Owners Assn, Corpus Christi.
Mar. 24-26—NGAA, annual meeting, Texas Hotel, Fort Worth, Texas.
Mar. 24-26—API, Mid-Continent production division, Broadview Hotel, Wichita, Kans.
Mar. 24-26—Southern Gas Assn, annual meeting, Galveston, Texas.
Apr. 5—Nomads, Louis Sherry's, 50th St. and Park Ave, New York City.
Apr. 5-7—Western Petroleum Refiners Assn, annual meeting, Galvez and Buccaneer Hotels, Galveston, Texas.
Apr. 5-8—Natl Assn Corrosion Engineers, annual meet, Jefferson Hotel, St. Louis, Mo.
Apr. 5-8—Oil Heat Institute of America, meeting and exposition, Coliseum, Chicago.
Apr. 13-15—Southern Gas Measurement Short Course, Univ. of Okla., Norman.
Apr. 14—Institute of Petroleum, Manson House, 26, Portland Place, London, W. I.
Apr. 14-16—API, Southwestern production division, Plaza Hotel, San Antonio, Texas.
Apr. 19-21—American Society of Lubricating Engineers, annual convention, Statler Hotel, Buffalo, N. Y.
Apr. 19-23—American Chemical Society, 113th national meeting, Chicago, Ill.
Apr. 21-23—National Petroleum Assn, Hotel Cleveland, Cleveland, Ohio.
Apr. 26-29—Am. Assn of Petroleum Geologists, Soc. of Economic Paleontologists & Mineralologists, & Soc. of Exploration Geophysicists, annual meeting, Denver, Colo.
Apr. 28-30—Liquefied Petroleum Gas Assn, annual convention, Kansas City, Mo.
May 4-5—AGA, National Gas Department, Spring meeting, Rice Hotel, Houston, Texas.
May 6-7—API, Pacific coast production division, Biltmore Hotel, Los Angeles.
May 12—Institute of Petroleum, Manson House, 26, Portland Place, London, W. I.
May 15-22—International Petroleum Exposition, Tulsa, Okla.
May 31—Gas Technology Short Course, Texas A & I College, Kingsville.
May 31-June 6—LPG Assn, annual convention and trade show, Sacramento, Calif.
June 21-25—ASTM, 51st annual meeting, Book-Cadillac Hotel, Detroit, Mich.
June 30-July 2—API, Eastern production division, Greenbrier Hotel, White Sulphur Springs, W. Va.

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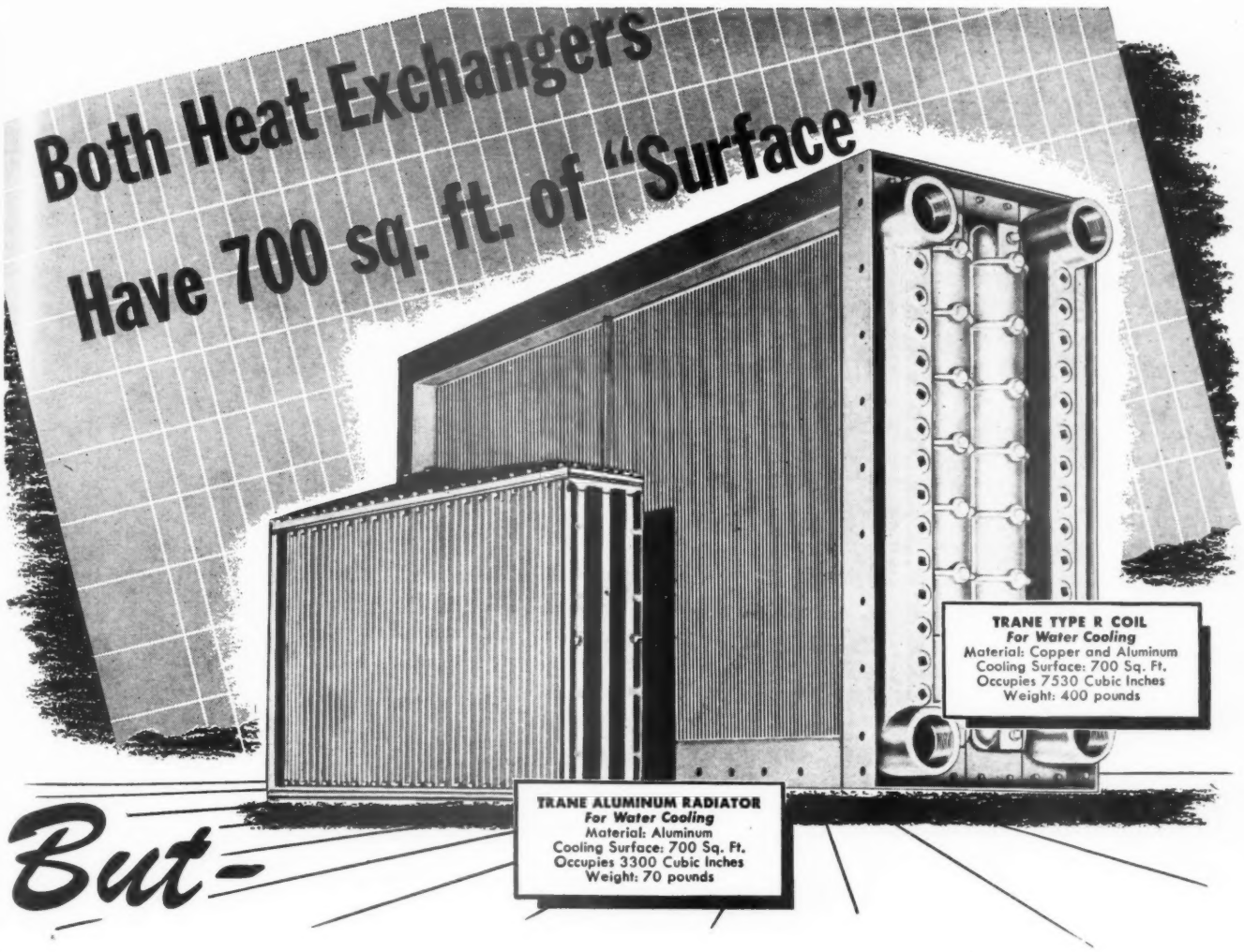

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IS PRICE INCENTIVE WORKING?

An article by H. J. Struth in this issue presents an interesting picture of 1947 operations. The figures he has compiled indicate that the nation's inventory of underground domestic reserves of oil have been increased during the last 12 months by more than a billion and a quarter barrels despite a record withdrawal of almost two billion barrels. Not only was the underground inventory of oil increased, the percentage of dry holes to all wells drilled for oil and gas also dropped about two and one-half per cent below that of 1946, and about three and one-half per cent below 1944. This is an encouraging change in trend.

Additions to reserves include new field discoveries and also revisions of old fields. Experience with revisions of the oil reserves in developed fields shows that preliminary estimates made when a field is discovered are much lower than later production and field data indicate they should be. This means that revisions are usually upward, and that present estimates of available oil reserves are probably on the conservative side.

Revisions and extensions enter largely into the addition of available domestic oil reserves. Of approximately three and a quarter billion barrels of oil added to available domestic oil reserves in 1947, only about one-half billion barrels was credited to new field discoveries; the rest, two and three-quarter billion barrels, was from extensions and revisions of pools previously discovered.

Replacement costs of oil are today five times greater than in the period 1939 to 1941. Should any large discoveries be made in 1948, it will likely go far toward reducing the unit cost of replacing oil reserves that have been and are being produced.

Wildcat drilling for natural gas increased during 1947 to such an extent that the total volume discovered may exceed that of any previous year.

Should the trends established in 1947 continue, the outlook for the oil industry in 1948 in the development of new domestic oil reserves is brighter than in several years.

The results of exploratory drilling in 1947 are significant. They are significant because of the conditions obtaining in the industry when the remarkable results were achieved. Additions to the nation's oil reserves are the greatest since 1937, and the downward trend in the rate of discovery, which has caused no little apprehension, particularly in Washington circles, seems to have been arrested. These results, however, should not have been entirely unexpected, for 1947 witnessed the drilling of the greatest number of exploratory wells in the history of the industry.

Drilling of so many exploratory wells despite shortages of tubular goods and casing was an extraordinary accomplishment. Due in part to wise distribution of available goods, the potent factor that spurred wildcatting to achieve such encouraging results appears to be the increase in crude prices.

Despite a serious shortage of casing, the impetus given to wildcatting and to development and production activities in general is not surprising. Average costs of finding new oil reserves are about six times what they were in prewar years, so an increase in crude price at this time was a sufficient stimulant to greater activity. Had casing and other tubular goods been in adequate supply in 1947, wildcatting and development drilling would have been more active and might have resulted in even larger additions to the nation's available oil reserves.

So far as producing wells are concerned, especially those of settled production, the price of crude is important. Each increase in the price of crude extends the economic life of such wells; conversely, a cut in the crude price shortens the economic life. Not only does an increase in crude price extend the economic life of wells, it is also a potent incentive to the operator, especially the small operator, to increase his rate of production and his ultimate recovery by working his wells over, an activity he can afford, and will engage in, when the price is right. This results in reducing the number of abandonments, and should automatically increase the ultimate recovery of oil.

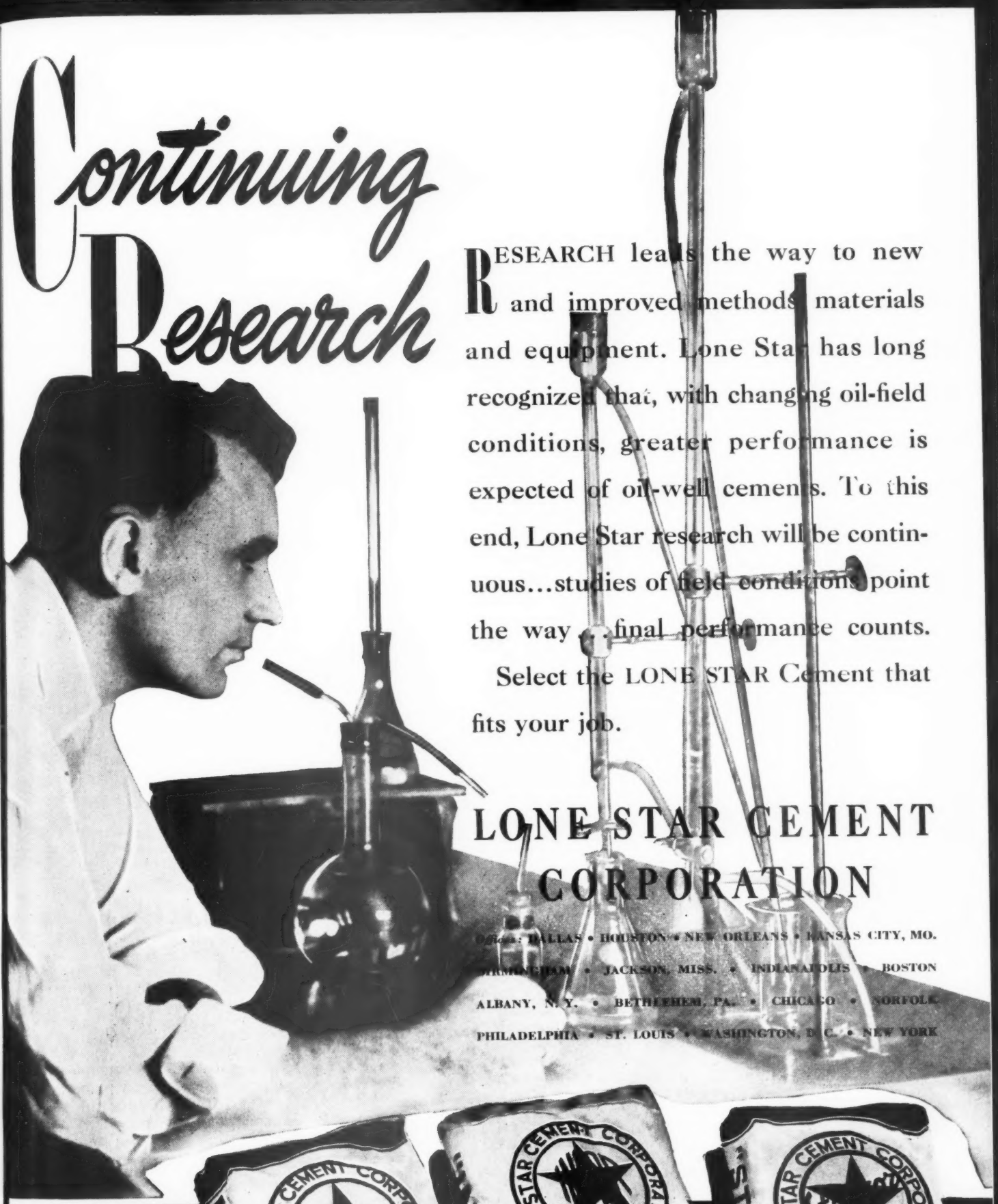
A price incentive should also result in an expansion of secondary recovery operations, and hence a substantial increase in ultimate recovery.

In the light of results attained in 1947, the rate of production, the rate of discovery, and additions to reserves may show a substantial increase in 1948, provided the price incentive is there and the supply of casing and other tubular goods improves.

Attention is called to an apt statement by Robert G. Dunlop of the Sun Oil Company: "Time and again in our industry it has been demonstrated that a substantial price increase for crude oil has always been followed by important new discoveries and by increased production from existing fields through the application of other means of recovery. These increases in production, as a result of price increases, have developed into crude oil surpluses with very definite effects upon the price structure, the historical ultimate being substantial price reductions."

Will history repeat itself?—K. C. S.

Continuing Research



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SCANNING WASHINGTON'S OIL HORIZON

By MILBURN PETTY

WASHINGTON—Enough of the congressional session has passed now to confirm expectations that petroleum will be one of the leading subjects of discussion, if not legislation, during the coming year.

Starting with the very first speech of the new session, in which Congressman Ross, New York Republican, attacked oil prices and demanded an investigation of the oil shortage, there has been scarcely a day when several senators and representatives did not take the floor to lecture the government or the industry on the petroleum situation.

A surprisingly large number of suggestions have come from both Republicans and Democrats for oil controls of one sort or another. And more will be forthcoming during the several investigations now under way on Capitol Hill.

Petroleum is right in the middle of the fight between President Truman and Congress over the need for giving the Truman Administration powers to allocate, ration, and control prices of scarce commodities such as fuels, including oil and gas. So far, Congress has denied Truman's request for these powers, fearing a return to OPA. Instead, the Taft Bill was enacted providing for voluntary agreements to deal with shortages. Success of such a program in the petroleum industry will depend on whether or not the various federal agencies drag their feet.

●

Meanwhile, some oil leaders are fearful that this voluntary program might lead to federal control.

"One step in such affairs," according to Russell B. Brown, general counsel for the Independent Petroleum Association of America, "inevitably leads to another. Each effort by government in oil industry matters has started with the avowed purpose of coordinating and has ended in administration. From the present excuse of devising a supply system to meet emergency needs it would be natural to seek the creation of a still greater agency to fit the petroleum industry of the United States into the program of foreign relief—a successor of the Petroleum Administration for War that would attempt world coordination of petroleum affairs."

Other industry leaders, on the other hand, are apprehensive that if they do not go along with a voluntary program, initiated by the Republicans in Congress as a substitute for President Truman's system of controls, they will be providing ammunition for Truman's renewed efforts to get such powers, especially if the oil shortage lengthens out into the summer and then to next winter.

●

Despite the industry's remarkable record of outdoing even its own hopes in increasing supply, there have been spot shortages of fuel oil, which have been aggravated by strikes, storms, and transportation delays. A continual barrage of appeals and complaints has created a congressional frame of mind on oil bordering on hysteria.

As a result, there is a definite possibility that, if rationing and price controls are voted on meat or any other scarce commodity, petroleum may be swept into the same bill. This danger will persist even if the industry squeaks by with a voluntary program and consumers cooperate by curtailing consumption. Spring will bring with it the prospect of a gasoline shortage, with predictions that next winter's fuel oil shortage will be worse than the present one. This will increase the pressure on Congress to give President Truman the fuel rationing and price control powers he is asking for "just in case they may be needed."

So, petroleum's fate is tied up with what happens on control of food and other necessities.

●

Another vital issue for oil and gas will be the fight over control of the tidelands. The Truman Administration's bill for controlling oil and gas development of all offshore submerged lands will reach Congress soon, running headlong into a bill renouncing federal claims and clearing title of the states to these lands. Right now, there appears to be some hope for enough votes to override a presidential veto of the states-rights bill.

Briefly, the Truman Administration's tidelands bill is expected to provide for: National Security Resources Board to be the policy maker on tidelands oil, with administration handled by a Submerged Lands Commission to be set up within Interior Department; valid state leases to be exchanged for federal leases except where the Commission decided that such is not in the national interest, in which case the present operator will be bought out (through this machinery, "government oil reserves" can be carved out of the submerged lands now being produced); also the President after consulting NSRB, could withdraw any other area from prospecting and hold it as a "government oil reserve" until the Navy or some other agency could test its possibilities; development and production to be strictly controlled by the Commission, carrying out NSRB's policies; federal government to have first call on any oil or gas production if needed for war or other emergency; and all submerged land leases to be open for exploration by anyone including any federal agency.

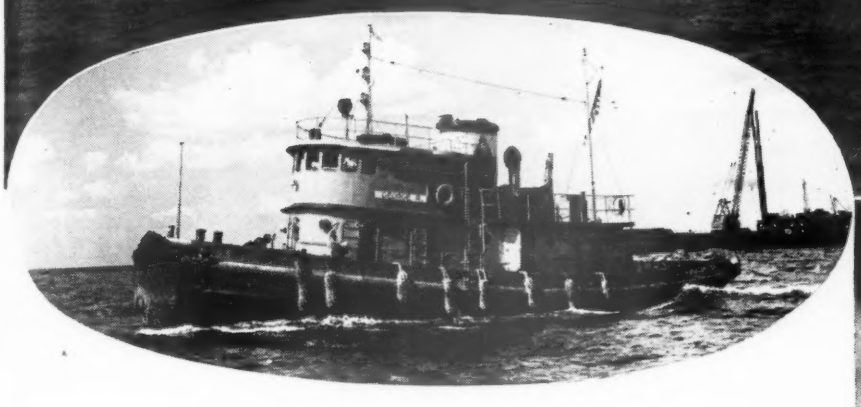
Military leaders, worried by expert advice that the United States cannot continue to find oil at the rate of even a billion barrels per year in the face of peacetime demand of more than two billion barrels this year, can be expected to press Congress for adoption of a national oil policy aimed at assuring adequate and accessible supplies for defense.

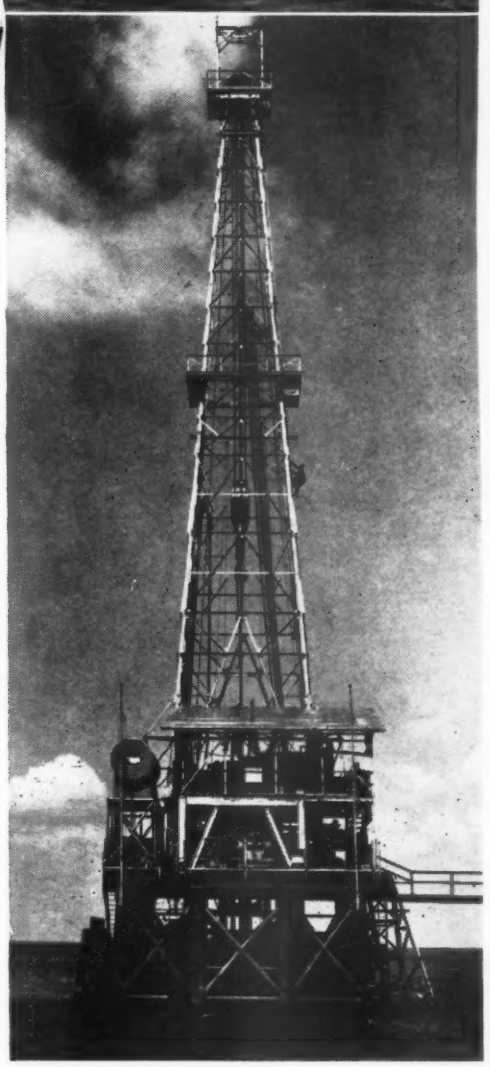
●

Among the military's recommendations will be positive steps to provide further incentives to the domestic industry to find more new oil. State Department will be urged by the military to go beyond mere diplomatic representation in opening up Latin American countries, especially Mexico, for American oil development. Since speedy development of American oil holdings in the Middle East is one of the Truman Administration's main objectives, full protection of our interests in that area can be counted on. With the military's backing, Interior Secretary Krug will seek an increased appropriation to speed up the government's synthetic fuels program.

It appears likely that some sort of compromise will be worked out between Federal Power Commission and congressional supporters of the Moore-Rizley Bill resulting in passage of legislation further delineating FPC's powers. One provision that the congressmen are insisting upon is that FPC be specifically denied any control over production or gathering of natural gas except possibly the authority to examine the accounts of such activities of interstate gas companies.

Now that President Truman is launched on a campaign against Big Business it can be expected that new antitrust proceedings involving oil and gas will be instituted between now and the November elections. Attorney General Clark has said that he plans to ask dismissal of the seven-year-old Mother Hubbard Case involving the American Petroleum Institute and over 200 major company defendants—but Clark will make certain that enough other oil cases have been filed or announced to offset any political repercussions.





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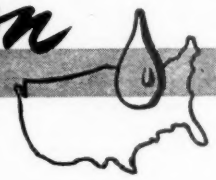
national petroleum situation



By H. J. STRUTH,*
Petroleum Economist

RECORD-BREAKING YEAR. Petroleum demand broke all records in 1947 with a daily average of 5,887,000 bbl, an increase of nearly 11 per cent over the demand of 5,321,000 bbl in 1946. The "tight" market situation experienced last year is shown by the fact that demand exceeded supply by 15,600 bbl. daily. Thus, where stocks increased 43,515,000 bbl in 1946, it was necessary to reduce them last year by 5,714,000 bbl.

"RUN" ON FUEL OILS. While demand for distillate fuels was expected to be the largest in oil history, the advent of extremely cold weather in the Northeast and Midwest brought a "run" on available supplies. Dealers absorbed all distillates available; home owners, apartment and commercial burner users filled their tanks. This created a demand, including exports, in December of 2,967,000 bbl daily and reduced national stocks to but 33 days' supply, against 47 days in November.

PETROLEUM SUPPLY ADEQUATE. Despite "shortage" talk, it is not believed that the nation actually faces a deficiency in petroleum supplies. Last year's "shortage" was less than 3/10ths of one per cent of the total demand. The real difficulty hinged not upon supply but upon lack of adequate transportation facilities and inequitable distribution of available supplies. The fact that the industry was able to meet the greatest demand in its history and had to withdraw only 15,600 bbl daily from storage to meet it is evidence of its ability to provide consumer needs.

IMPROVED FACILITIES. The year 1947 brought the greatest exploration activity in the industry's history, resulting in the discovery of the largest quantity of new reserves since 1937. Crude production in December of 5,327,000 bbl daily was 602,000 bbl greater than 1946; refinery runs of 5,363,000 bbl daily were 583,000 bbl above 1946. Natural gasoline production last year was 13 per cent above 1946. These accomplishments and more in prospect for 1948 offer conclusive reasons for confidence in the industry's ability to meet future oil requirements.

*Editor, *The Petroleum Data Book.*

Comparative Statistics, December, 1947

*All figures are computed on a Bureau of Mines' Basis**

	Dec. 1947(P)	Nov. 1947(P)	Dec. 1946	This year to date	Last year to date	Per cent change
Wells drilling	4,400	4,600	4,000	4,400	4,000	+10
Total wells drilled§	3,060	3,056	2,581	¶34,390	29,654	+16
Development wells	2,588	2,581	2,134	¶29,189	25,049	+17
Oil	1,563	1,527	1,235	¶17,875	14,771	+21
Gas	259	280	284	¶3,335	3,103	+ 7
Dry§	766	774	615	¶7,979	7,175	+11
Per cent dry	29.6	30.0	28.8	27.3	28.6	— 1.3
Wildcat wells	472	475	447	¶5,201	4,605	+13
Oil	52	66	48	¶786	639	+23
Gas	25	18	14	¶223	135	+65
Dry	395	391	385	¶4,192	3,831	+ 9
Per cent dry	83.7	82.3	86.1	80.6	83.2	— 2.6
Crude supply⊕	172,890	167,000	153,532	1,952,856	1,819,490	+ 7
Daily average	5,577	5,567	4,953	5,350	4,985	
Crude demand‡	175,290	167,460	155,144	1,953,945	1,812,573	+ 8
Daily average	5,655	5,582	5,005	5,353	4,966	
Crude stocks	229,080	¶231,480	230,176	229,080	230,176	0
Days supply	41	41	46	41	46	
Natural gasoline production	11,470	11,000	10,501	130,262	115,153	+13
Daily average	370	367	339	357	315	
Motor fuel production	75,050	¶72,830	69,028	840,565	776,654	+ 8
Daily average	2,421	2,428	2,227	2,303	2,126	
Gasoline yield, per cent	40.2	40.8	41.4	40.2	39.6	+ 0.6
Motor fuel demand‡	68,720	¶68,260	64,981	840,467	780,222	+ 8
Daily average	2,217	2,275	2,096	2,303	2,138	
Motor fuel stocks△	89,830	83,500	89,515	89,830	89,515	0
Days supply	41	37	43	41	43	
Fuel oil production	70,030	¶64,650	60,907	758,545	719,260	+ 5
Daily average	2,259	2,155	1,965	2,078	1,971	
Fuel oil demand‡	91,980	¶73,300	82,387	853,157	758,955	+12
Daily average	2,967	2,443	2,658	2,337	2,079	
Fuel oil stocks	98,170	113,750	106,714	98,170	106,714	— 8
Days supply	33	47	40	33	40	
Refinery still runs	166,260	158,300	148,171	1,852,229	1,730,197	+ 7
Daily average	5,363	5,277	4,780	5,075	4,740	
All refined stocks	272,300	¶284,800	276,918	272,300	276,918	— 2
Days supply	42	48	47	42	47	

Supply and Demand—All Oils

	Dec. 1947(P)	Nov. 1947(P)	Dec. 1946	This year to date	Last year to date	Per cent change
All oils supply	188,812	182,440	169,447	2,142,900	1,985,680	+ 8
Daily average	6,091	6,081	5,466	5,871	5,440	
All oils demand‡	203,712	180,400	185,395	2,148,614	1,942,165	+11
Daily average	6,571	6,013	5,980	5,887	5,321	
Change in stocks, all oils	−14,900	+2,040	−15,948	−5,714	+43,515	

Current Crude Oil Prices

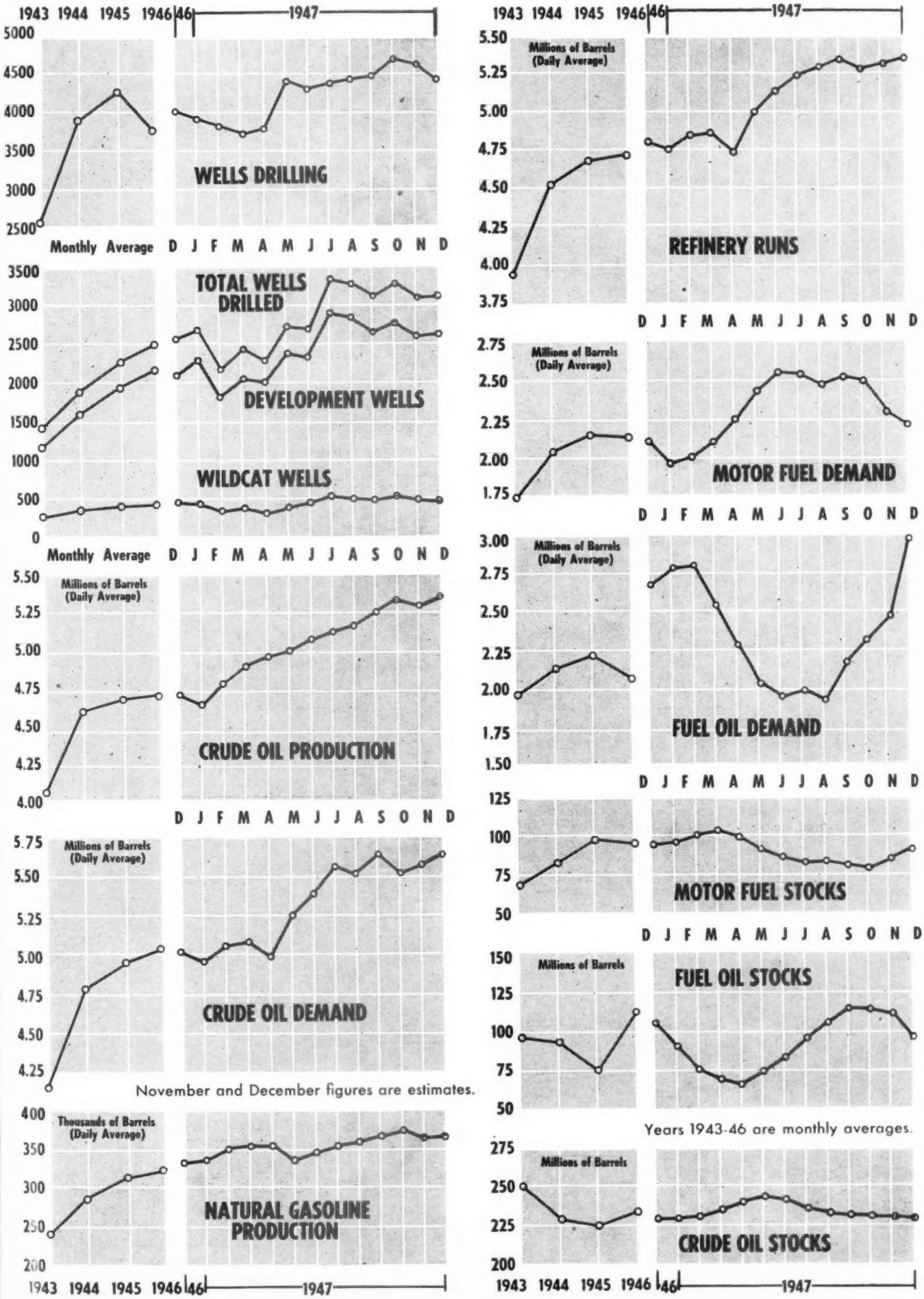
U. S. average	$2.61	Louisiana	$2.62	**Basic crude prices:**	
Texas	2.61	Arkansas	2.43	Oklahoma-Kansas (36 gr.)	$2.57
California	2.42	New Mexico	2.40	Texas Gulf Coast (36 gr.)	2.80
Oklahoma	2.63	Mississippi	2.42	East Texas	2.65
Kansas	2.62	Illinois	2.76	West Texas (36 gr.)	2.44
		Other states	3.15	California Signal Hill (26 gr.)	2.41
				Pennsylvania, Bradford	5.00

Drilling and Production Statistics by States

	Dec. 1947(P)	Nov. 1947(P)	Dec. 1946	This year to date	Last year to date	Per cent change
Total wells drilled§	3,060	3,056	2,581	¶34,390	29,654	+16
Texas	782	828	648	¶9,730	7,871	+24
California	207	179	146	2,074	1,808	+15
Oklahoma	333	299	330	¶4,131	3,116	+33
Kansas	269	250	233	¶2,774	2,085	+33
Louisiana	165	180	116	1,693	1,413	+20
Arkansas	26	41	19	342	188	+82
New Mexico	69	44	37	575	401	+43
Mississippi	44	35	38	495	264	+88
Illinois	191	182	216	2,094	2,383	−12
Other states	974	1,018	798	10,482	10,125	+ 4
Wildcats drilled	472	475	447	¶5,201	4,605	+13
Texas	165	191	152	¶1,912	1,682	+14
California	35	23	33	346	260	+33
Oklahoma	87	68	88	¶885	593	+49
Kansas	39	32	24	407	308	+32
Louisiana	17	31	18	284	249	+14
Arkansas	7	7	9	72	47	+53
New Mexico	4	5	2	49	43	+14
Mississippi	6	7	16	93	84	+11
Illinois	41	29	45	¶410	604	−32
Other states	70	82	60	¶743	735	+ 1
Daily crude production	5,327	5,310	4,725	5,086	4,749	+ 7
Texas	2,360	2,351	2,022	2,243	2,084	+ 8
California	927	¶925	879	912	864	+ 6
Oklahoma	413	¶414	355	388	368	+ 5
Kansas	289	295	271	288	266	+ 8
Louisiana	466	465	414	439	393	+12
Arkansas	87	¶85	79	82	78	+ 5
New Mexico	125	¶125	103	113	101	+12
Mississippi	112	¶110	84	97	66	+47
Illinois	182	¶183	197	183	206	−11
Other states	366	¶357	321	341	323	+ 6

*Unless otherwise stated all figures represent thousands of barrels. (P)–Preliminary. ⊕Includes domestic production and imports.
‡Total demand, including exports. △Includes finished and natural gasoline. §Includes service wells. ¶Revised.

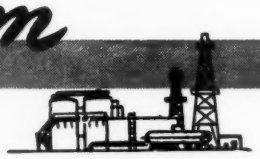
Preliminary estimates based upon data supplied by American Petroleum Institute, U. S. Bureau of Mines, State Agencies, and other official sources.



November and December figures are estimates.

Years 1943-46 are monthly averages.

highlights in oildom



● **GAS SALE REGULATION WITH STATES.** The U. S. Supreme Court has upheld the right of states to regulate the sale of natural gas by interstate pipe line companies directly to industrial customers.

The 8 to 0 ruling was made in a case involving Panhandle Eastern Pipe Line Company and the state of Indiana. The company had contended such sales were free from all regulation, state or federal.

● **OIL INDUSTRY'S STEEL NEEDS.** In report now being issued the Independent Petroleum Association of America analyzes the need of the petroleum industry for steel—particularly casing and tubular goods—for drilling and producing wells. The comprehensive analysis reviews 20 years of petroleum development in the United States in order to obtain factual information of present and future requirements for steel needs by the industry. The report shows that during the year just being completed as well as through 1946 a serious shortage of steel materials retarded drilling and the development of oil and gas areas, and also necessitated the use of secondhand materials. In order to obtain this latter steel it was frequently necessary to abandon prematurely wells of small production. This, the report points out, has resulted in the loss of many thousands of barrels of producible reserves.

From a national viewpoint the report shows that drilling during the past year was 20 per cent under what it should have been; a condition directly reflective of the inadequacy of the supply of steel materials. During 1946 only 1,000,000 tons of casing, tubing, and drill pipe for use in the United States were available, and this compares with a need for 1,450,000 tons for 1948 if normal drilling is to rebuild our productive capacity. At a very minimum, merely to meet the increasing demands for crude oil and products, operators will require 1,245,000 tons during 1948. The report differentiates between minimum and normal needs by showing that through the war period the industry reduced its productive capacity to supply the needs that were urgent at that time, and that today's drilling program, to be considered normal, should regain the deficiencies in productive capacity created during the war years.

Demand for crude oil and products has never been higher, the Independent Petroleum Association report concludes, and it is essential that steel be available in quantities sufficient to support the industry's program. Eleven tons of steel are needed for every 1000 ft of hole drilled, the association has determined by establishing a relationship between total footage and steel requirements. This relationship cannot be adjusted downward without reducing total wells drilled. The only answer to the necessity of increased drilling is more steel, the report finds. There is no reason to anticipate a decrease in the demand for oil products, and there is need to develop a surplus producing capacity against any unusual future demand.

● **SEES EXPANSION GAS INDUSTRY 1948.** Limited only by shortages of steel and other vital materials needed for the expansion of production, transmission and distribution facilities, the utility gas industry in 1948 will continue its unbroken record of expansion.

That is the prediction of Hudson W. Reed, president, American Gas Association.

"New operating methods and an industry-wide integrated research and promotional program on a scale hitherto unapproached hold great promise for the coming year," Reed said.

At the end of 1947 there were 21,590,000 customers of gas utility companies, an increase of 3.2 per cent from the end of 1946. Based on this nominal rate of gain, the gas utilities will be serving more than 22,000,000 customers at the end of 1948.

By far the most phenomenal expansion has been in the natural gas branch of the industry. Construction and operation of new facilities during 1947 have increased capacity of the nation's gas pipeline system by nearly 2,000,000,000 cu ft a day.

Such construction added 5370 miles of pipe lines to bring the network up to 229,000 miles.

● **EXPORT QUOTA FOR FIRST QUARTER.** An export quota of 12,000,000 bbl of petroleum products has been established for the first quarter of 1948, the Office of International Trade, Department of Commerce, has announced. This quota continues the policy of restricting exports of major petroleum products to the maximum extent possible until the current domestic shortages are alleviated.

The 12,000,000 bbl quota figure compares with shipments of more than 17,000,000 bbl in the first quarter of 1947. As the current established quota is substantially below estimated export demand, export licenses will be approved only on the basis of the most urgent need, OIT stated.

The first quarter of 1948 product breakdown of the quota is as follows:

Blending agents	150,000 bbl.
Aviation gasoline	700,000 bbl
Motor gasoline	5,250,000 bbl
Kerosine	900,000 bbl
Gas oil and distillate fuel oil	3,200,000 bbl
Residual fuel oil	1,800,000 bbl
Total	12,000,000 bbl

In addition 2,470,000 bbl of petroleum products have been authorized for shipment by the U. S. military authorities to Greece and the occupied areas of Japan and the Ryukus Islands to meet the requirements of special programs.

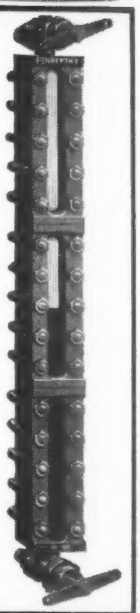
● **PETROLEUM COMMITTEE NAMED.** Walter S. Hallanan, chairman of the National Petroleum Council, has announced the appointment of a committee on voluntary petroleum agreements under Public Law 395. This committee was recently authorized by the council's agenda committee in response to the request of J. A. Krug, Secretary of the Interior, for a committee to make such recommendations to the National Petroleum Council as it deems appropriate regarding voluntary agreements that can be taken by industry under Public Law 395 with respect to petroleum. Secretary Krug's request indicated there is a need for action with respect to the orderly and equitable distribution of petroleum and its products.

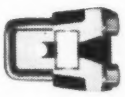
Those named to the committee are as follows: Chairman, Robert E. Wilson, Standard Oil Company (Indiana), Chicago; H. T. Ashton, Western Petroleum Refiners Association, St. Louis; Jacob Blaustein, American Trading and Production Corporation, Baltimore; Russell B. Brown, Independent Petroleum Association of America, Washington; H. S. M. Burns, Shell Oil Company, New York; Fayette B. Dow, National Petroleum Association, Washington; John Dressler, New Jersey Gasoline Retailers Association, Hackensack, New Jersey; R. G. Follis, Standard Oil Company of California, San Francisco; B. C. Graves, Union Tank Car Company, Chicago; B. I. Graves, Tide Water Associated Oil Company, New York; J. Parks Gwaltney, National Council of Independent Petroleum Associations, Durham, North Carolina; Geo. A. Hill, Jr., Houston Oil Company of Texas, Houston; Walter Hochuli, The Texas Company, New York; W. T. Holliday, Standard Oil Company (Ohio), Cleveland; Eugene Holman, Standard Oil Company (N. J.), New York; W. Alton Jones, Cities Service Company, New York; B. L. Majewski, Deep Rock Oil Corporation, Chicago; J. Howard Marshall, National Stripper Well Association, Ashland, Kentucky; Clyde G. Morrill, Atlantic Coast Oil Conference, New York; I. A. O'Shaughnessy, The Globe Oil and Refining Company, St. Paul; Sidney Swensrud, Gulf Oil Corporation, Pittsburgh; L. S. Wescoat, The Pure Oil Company, Chicago; H. C. Wiess, Humble Oil & Refining Company, Houston, and Russel S. Williams, Individually Branded Petroleum Association of America, Indianapolis.

PENBERTHY
"REFLEX"
DROP FORGED STEEL LIQUID LEVEL GAGES

Liquid always shows black—empty space shows white. Preferred where the liquid level must be easily and positively visible, and when liquids are under high pressure or at high temperature. Made of alloy temperature resisting steel and are highest quality throughout. Liquid chamber made from solid block of steel to assure perfect alignment and rigidity. Conform with A.P.I.—A.S.M.E. requirements.

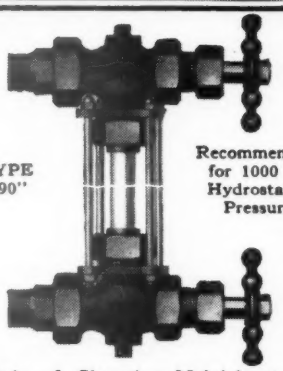
The "Reflex" is one of the complete line of Penberthy Gages that meet every liquid level gage requirement.





PENBERTHY INJECTOR CO.
DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

PENBERTHY
DROP FORGED STEEL LIQUID LEVEL GAGES



TYPE "90"

Recommended for 1000 lb Hydrostatic Pressure

Made of Chromium-Molybdenuin alloy temperature resisting steel, extra heavy throughout and stainless steel trimmed. Positive automatic shut-off; stainless steel balls shut off the flow of liquid if glass breaks. Regrinding removable seats, heavy duty stuffing boxes, union connections. Conform with A.P.I.—A.S.M.E. requirements.

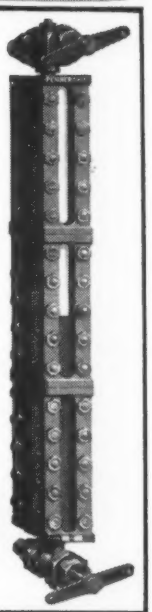
This is one of the complete line of Penberthy gages that meet every liquid level gage requirement.

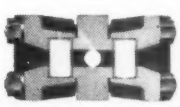
PENBERTHY INJECTOR CO.
DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

PENBERTHY
"TRANSPARENT"
DROP FORGED STEEL LIQUID LEVEL GAGES

Used to observe color and density of liquids under high pressures and/or temperatures. Construction exceptionally sturdy. Made of alloy temperature resisting steel, and are highest quality throughout. Liquid chamber made from solid block of steel to assure perfect alignment and rigidity. Conform with A.P.I.—A.S.M.E. requirements.

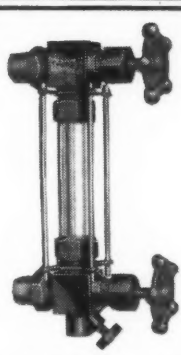
The "Transparent" is one of the complete line of Penberthy gages that meet every liquid level gage requirement.





PENBERTHY INJECTOR CO.
DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

PENBERTHY
"ALL IRON"
LIQUID LEVEL GAGES

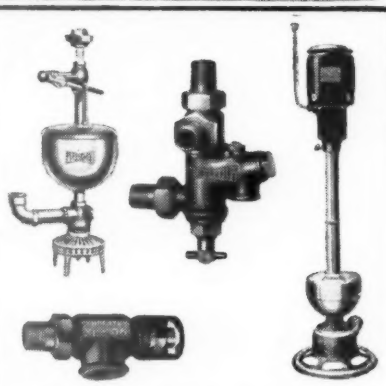


Body made from a special high strength alloy iron, shanks alloy steel and trim stainless steel. Extra heavy construction throughout, automatic and positive shut-off if glass breaks, heavy duty stuffing boxes. Conform with A.P.I.—A.S.M.E. requirements.

The "All Iron" is one of the complete line of Penberthy gages that meet every liquid level gage requirement.

PENBERTHY INJECTOR CO.
DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

PENBERTHY
QUALITY PRODUCTS

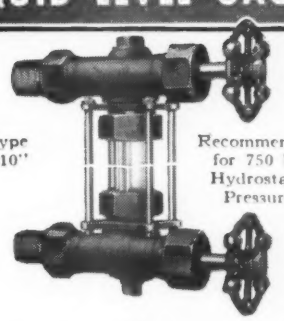


Penberthy injectors—ejectors—automatic electric and water (or steam) operated sump pumps are all widely used throughout the oil industry because they have always been dependable under the most severe service conditions.

All are of rugged construction and made by an organization with 59 years experience in the manufacture of highest quality products.

PENBERTHY INJECTOR CO.
DETROIT 2, MICH. Canadian Plant WINDSOR, ONTARIO

PENBERTHY
DROP FORGED STEEL LIQUID LEVEL GAGES



Type "10"

Recommended for 750 lb. Hydrostatic Pressure

Steel construction throughout with stainless steel interior trim. Automatic shut-off is positive and instantaneous; stainless steel balls shut off the flow of liquid when glass breaks. Heavy duty stuffing boxes, union connections, offset construction facilitate cleaning and simplify glass replacement. Conform with A.P.I.—A.S.M.E. requirements.

This is one of the complete line of Penberthy gages that meet every liquid level gage requirement.

PENBERTHY INJECTOR CO.
DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

current oil field operations

Exploration wells that have found production.

● **TEXAS.** Continental 1 J. F. Welder, Calallen area, San Patricio. 134 BOPD 40° 5900 ft.

Continental 1 Lloyd Bentsen, Javelina Ranch area, Hidalgo. 225 BOPD 42.5° Frio 5396-409 ft.

Cities Service 1 Manning, Tarleton sur, Wise. 400 BOPD 41° Bend conglomerate 5203-35 ft.

Panhandle 2 Brundidge, H. M. Jones sur-A-1612, Young. 20-30 BOPH Mississippi 4454-74 ft and 53 B oil in 6 hr Caddo 3351-69 ft.

Harvey Drlg 1 J. B. Waide, T. Carpenter sur-A-271, Denton. 26 BOPD from 1644-58 ft.

Frazier, Grubb & Hawkins 1 J. R. Farmer, Fort Bend. 100 B cond & 2942 MCF gas daily from 7415-20 ft and 66 B cond & 706 MCF gas daily from 7260-65 ft.

Humble 2 Vick, Smith league, Lee. 250 BOPD 32.5° Georgetown lime 6111-19.

Atlantic et al 1 F. O. Mastern, league 132, Carson. Swb 32 BOPH 4950-5050 ft.

Snowden et al & Freedman 1 Wright, blk 294, BBB&C sur, Throckmorton. Oil & gas from Caddo 4235-80 ft, 4319-29 ft and 4354-61 ft.

Manning 1-F Parrott, blk 968, TE&L sur, Throckmorton. Mississippi lime discovery 4518-27 ft.

Texas 1 Henson, sec 1, CSL sur, Montague. 155 B oil in 3 hr Bend conglomerate 6236-44 ft.

Humble 1 Lutrick, sec 14, EL&RR sur, Hale. DST oil from 7920-80 ft and 7912-90 ft.

Shell 1 Chambers, Chambers CSL sur, Crockett. 30-min DST 1500 MF gas & 14 B 44° oil Ellenburger 7510-35 ft.

Kadane & Sons 1-A Quizenberry, Leaman sur, Baylor. 75-100 BOPD Palo Pinto 3132-42 ft.

Stanolind 8-B University, sec 13, blk 18, University Land, Pecos. 1-hr DST gas & 2100 ft 25° oil lower Permian 3938-4008 ft.

Continental & Texas 1 D. B. Benson, Stoneburg blk, Montague. 1192 BOPD 41° conglomerate 6236-44 ft.

Slick-Urschel 1 Alford, Upton. 500 BOPD Ellenburger 11,855-985 ft.

Seaboard 1-B Caldwell, sec 32, blk 32, twp 3, Howard. DST 3 MMF gas daily & oil Pennsylvanian 7938-68 ft.

Sinclair Prairie 1 Mary Gronow, L. F. Fisch sur, A-283, Montague. Swb 10 BOPH Strawn 4079-89 ft.

● **INDIANA.** Joe Reznik 1 Feil SW SW SW 28-4s-10w Vanderburgh. 217 BOPD O'Hara 2210-14 ft.

Heath & Ind. Farm Bureau 1 Austin Heirs SW SE NW 32-6s-9e White. 40 BOPD Bridgeport 1915-45 ft.

● **EGYPT.** Anglo-Egyptian field in Sudr district of Sinai Peninsula. Five producers with a total IP of 5000 BOPD.

● **COLORADO.** Texas & Frontier Maudlin Gulch well, CNL NW NW 35-4n-95w Moffat. 61 BOPD 35° Morrison 6245 ft.

● **NEW MEXICO.** Gulf 11 McCormick 32-21s-37e Brunson area, Lea. 487 BOPD 43.6° Silurian 7221 ft.

Byrd-Frost et al 1 Feasel NE NE 2-29n-10w Kutz Canon, San Juan. 2240 MCF gas 1950-2032 ft.

● **ILLINOIS.** B. Lambert et al 1 Robinson Heirs SW SE NE 27-3s-10e White. 65 BOPD Cypress 2858-69 ft.

Phillips 1 Book NW SE SW 31-2s-8e Wayne. 147 B oil in 20 hr McClosky 3375-85 ft.

● **ARKANSAS.** Houston 1 Gaughan C SW SW NE 34-13s-16w Calhoun. 255 B oil in 17 hr Meakin 1900-2003 ft.

● **KANSAS.** John Lindas 1 Hutchinson SE SE NW 17-23s-17w Pawnee. 40 BOPD from 4273-90 ft.

El Dorado Ref 1 Chamberlin NW NW NE 18-19-10w Rice. 376 BOPD Arbuckle 3335 ft.

Stanolind 1 Wheatley CNE SW 23-33-31w Seward. Swb 107 B oil in 6 hr Mississippi 5910-20 ft.

Derby 1 Jelinek NW NE SE 23-9-19w Rooks. Swb 45 BOPH Arbuckle 3552 ft.

Brack 1 Hoffman NE NE SW 32-13-17w, Younger North field, Ellis. 25 BOPD Arbuckle.

Drillers Gas 1 Rombach NW NE 11-27-1w Sedgwick. 72 BOPD Kansas City lime 2715-20 ft.

● **LOUISIANA.** Crisby Drlg 4 Clifton Land Corp, Napoleonville field, Assumption. 16 BOPH 32° from 5395-5403 ft & 5358-70 ft. First oil sand.

Skelly 1 Thelma Nash 20-12n-16w DeSoto. 68 B 45° in 5 hr Pettit 6160-80 ft.

● **MISSISSIPPI.** J. W. Hughes and C. W. Sistrunk 1 GM&ORR 24-9n-8w Wayne. DST 220 ft oil Eutaw 5127-50 ft. Three other good shows in Eutaw.

Start of 4000-ft test on London playground.

● **OKLAHOMA.** A. G. Oliphant 1 NW NW NW 13-25n-5e Osage. DST 1700 ft oil in few hr from Mississippi lime & chat 2928½-30 ft.

British-American, Harper & Turner 1 Kramer C SW NW 13-12n-2w Oklahoma. DST 3500 MCF gas from 6210-45 ft.

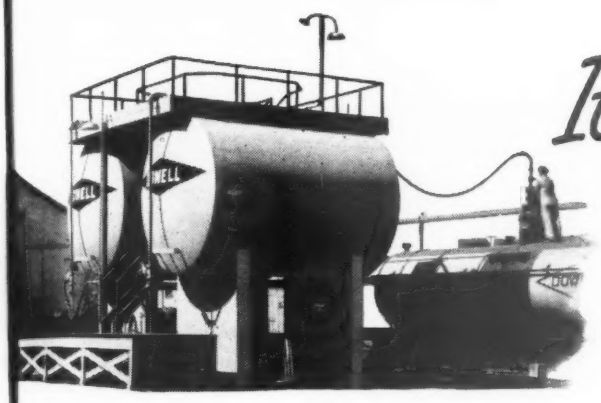
Deardorf 1 Anderson SW SW NE 15-17n-3e Payne. 8 MMCF gas & 50-100 B cond Bartlesville 3982-87 ft.

Carter 1 Tilghman C SW NE 7-4n-3w, E. Lindsay pool, Garvin. 40-min DST 8 MMCF gas daily & 900 ft 45° oil from 9978-10,025 ft.

Stanolind 1 Briscoe C NW SE 4-4n 5w Grady. 388 B oil in 24 hr from 14,238 ft. Deepest oil producing well.

Mid-Continent 1 Berry Estate NW SW SW 32-9n-3w McClain. 60 BOPH Bois d'Arc 8784-830 ft.

Carter 1 Cronian NE SW SE 32-4n-2w Garvin. 35 BOPH Bromide 6810-18 ft.



It isn't the acid!

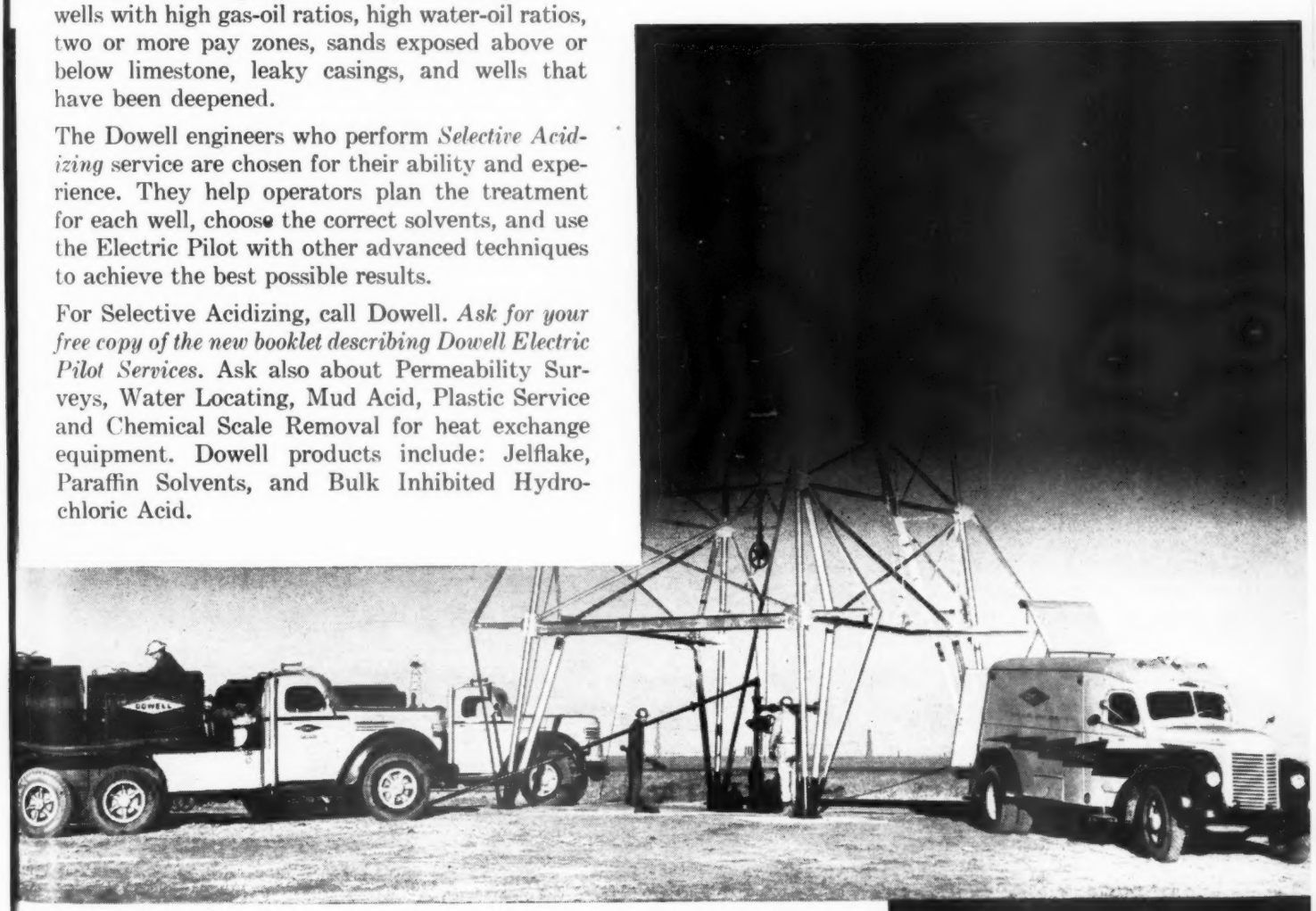
It's how the acid is used that counts!
Who uses it . . . where . . . and how?
How much to use—and why?

SELECTIVE ACIDIZING calls for selected men, materials, methods

To produce best results, it is now possible to direct acid and other well-treating chemicals into *selected* zones through use of the Dowell Electric Pilot. Selective acidizing is particularly advantageous in wells with high gas-oil ratios, high water-oil ratios, two or more pay zones, sands exposed above or below limestone, leaky casings, and wells that have been deepened.

The Dowell engineers who perform *Selective Acidizing* service are chosen for their ability and experience. They help operators plan the treatment for each well, choose the correct solvents, and use the Electric Pilot with other advanced techniques to achieve the best possible results.

For Selective Acidizing, call Dowell. *Ask for your free copy of the new booklet describing Dowell Electric Pilot Services.* Ask also about Permeability Surveys, Water Locating, Mud Acid, Plastic Service and Chemical Scale Removal for heat exchange equipment. Dowell products include: Jelflake, Paraffin Solvents, and Bulk Inhibited Hydrochloric Acid.

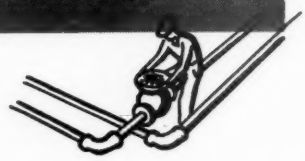


OKLAHOMA EXAMPLE: *An Electric Pilot survey on a well previously acidized three times showed most of the permeability was in the middle pay zone. The well was selectively acidized using the Electric Pilot, the acid being directed into lower and less permeable sections. Results: Sustained flowing production of 250 BOPD on 1/4 choke with 600 lb. tubing pressure.*

DOWELL

DOWELL INCORPORATED • TULSA 3, OKLAHOMA
Subsidiary of The Dow Chemical Company

pipeline developments



● **BIG PIPE LINE WORK BEGUN.** American Light and Traction Company is the approved company for an integrated gas utility system, which has begun building a $104,000,000 natural gas pipe line into Michigan and Wisconsin. Companies involved are Michigan Consolidated Gas Company, Detroit; Milwaukee Gas Light Company; Austin Field Pipe Line Company, Milwaukee Solvay Coke Company, and Michigan-Wisconsin Pipe Line Company—the firm which will build the pipe line.

The 24-in. line will extend from the Hugoton gas field in Texas 1500 miles through Oklahoma, Kansas, Missouri, and Iowa to a point near Millbrook, Ill., from there it will be a 22-inch line through Indiana to the Austin field in Michigan. Scheduled for completion in 1950, the line will triple the supply of gas in the Detroit area.

Constructoin began about the middle of December on the Oklahoma end. Three crews are also working at the northern end of the line.

● **PLANS 3⅓ MILLION-DOLLAR EXPANSION.** El Paso Natural Gas Company is to construct additional natural gas pipeline facilities at an estimated capital cost of $3,323,000.

The company proposes by means of these facilities to deliver a total of 20,000,000 cu ft of natural gas daily to Arizona companies.

Facilities authorized include about 83 miles of pipe line ranging in size from 4½ in. to 16-in., 7600 hp compressor capacity; a dehydration plant addition; a gas purification plant addition and appurtenant equipment.

● **UNDERGROUND STORAGE.** The Ohio Fuel Gas Company has FPC authorization to construct facilities to develop additional underground storage capacity. Gas would be stored during summer months for use in winter.

The company plans to construct a natural gas compressor station with five units totaling 6350 hp; 22 miles of 16-in. gas transmission lines, and extend present Perryville storage area by adding 13 partially depleted producing wells for an estimated storage capacity of 1½ billion cubic feet. Cost of the construction is estimated at $2,310,800 less about $200,000 for salvage.

● **LET CONTRACT FOR ELECTRICAL EQUIPMENT.** Westinghouse has been awarded a contract to supply electrical equipment for a new crude oil pipe line in which Shell Pipe Line Corporation and The Texas Pipe Line Company will own undivided interests. The line will originate at Cushing, Oklahoma, and have terminals at Wood River and Salem, Illinois.

The approximate throughput capacity of 200,000 bbl per day makes this one of the largest oil pipe lines to be built by private capital. More than 35,000 hp in electric motors will be required to power the 8 pumping stations. At each station, three 1250-hp motors and one 700-hp motor will drive the main pumping units and a number of smaller motors will be required for auxiliary services. Power will be delivered through 8 outdoor substations composed of three 1667-kva transformers and related switching equipment. Shipment of the electrical equipment is to start early in the fall of 1948. The pipe line is scheduled for completion in the first quarter of 1949.

● **EXPAND GAS FACILITIES.** Home Gas Company, The Manufacturers Light and Heat Company, and Cumberland and Allegheny Gas Company were granted FPC authorization to construct additional natural gas transmission facilities.

Under this temporary authorization Home will install two regulator stations in Deer Park Town, Orange County, New York. Manufacturers Light and Heat will construct 1000 ft of 14-in. line, a 1000 hp compressor station, a gas measuring station, and a regulator station to enable it to receive gas from Texas Eastern Transmission Corporation in Chester County, Pennsylvania, and a 375 hp compressor unit at its Waynesburg compressor station in Green County, Pennsylvania. Cumberland and Allegheny will construct 7 miles of 6-in gas transmission line between Terra Alta, West Virginia and Oakland, Maryland.

● **ADDS LOOP LINES AND COMPRESSORS.** The initial decision and order authorizing Mississippi River Fuel Company to construct facilities consisting of additional loop lines and compressor units has become effective as the final order and decision of the Federal Power Commission.

Under this order, the company was authorized to construct an aggregate of 199 miles of 22-in. pipe line, 20 miles of 10-in. pipe line in 6-line manifolds at stream crossings, and 2.3 miles of 12-in. pipe line in 4-line manifolds at stream crossings, together with 11,000 hp of compressor units. The loop lines would connect existing and authorized sections of pipe line along and parallel to the company's main 22-in. line and would complete an entire looping of this line, resulting in two separate main lines. The additional facilities would increase the company's authorized daily sales capacity of 183,000,000 cu ft of gas by 83,000,000 cu ft. Cost has been estimated at $13,654,140.

Mississippi River Fuel transports and sells natural gas at wholesale in Arkansas, Illinois, and Missouri. The principal deliveries are made in the St. Louis area.

● **CALIFORNIA GAS FIRM PLANS EXPANSION.** Natural gas for Imperial Valley is in prospect through a deal now pending between Coast Counties Gas and Electric Company and Southern California Gas Company. The latter would acquire the gas properties now being operated by Coast Counties company in Imperial Valley. The transaction involves a purchase price of approximately $800,000 for butane-air generating plants, mains and services and other properties in Brawley, El Centro, and Calexico.

As soon as pipe becomes more readily available, Southern plans to apply for authority to expend approximately $1,000,000 on a transmission line from the 30-in. "Biggest Inch" to Valley towns, making Texas natural gas available for distribution. The projected pipe line will be routed through Niland, Calipatria, Imperial, and Holtville permitting gas to be served in those communities as well as the other cities in the Valley now enjoying service.

Southern California Gas Company is the oldest gas utility company in this part of the state, and today is one of the largest natural gas distributing companies in the world. The company presently distributes gas in Los Angeles, Riverside and San Bernardino Counties and in several counties in the San Joaquin Valley, as well.

In a joint venture with Southern Counties Gas Company and the El Paso Natural Gas Company, the company is in the process of completing a 1200-mile pipe line to Texas, augmenting its sources of supply in California by tying in with natural gas reserves in Texas, New Mexico and the Kansas area. By 1949, the El Paso Natural Gas Company will be able to deliver gas through the new pipe line at a rate of 305,000,000 cu ft a day.

● **WYOMING LINE ALMOST COMPLETE.** The Medicine Bow field in Albany County, Wyoming, which has been a producer since 1935, is scheduled to have a pipe line outlet for its oil in the near future. The Rocky Mountain Gas Company, subsidiary of the Ohio Oil Company, has let a contract to Dawson and Corbett of Rawlins, Wyoming, for the construction of a 9-in line to extend from the field to Rawlins, a distance of 54 miles.

Construction of the line is now under way with approximately half of it completed. Due to the difficulty in getting pipe the remaining half of the line probably will not be completed until some time in early 1948. Since the Medicine Bow field was discovered in June, 1935, it has produced more than 5,000,000 bbl of 63 gravity oil from the Sundance sand.

● **INCREASES STORAGE FACILITIES.** Marine Oil Terminal Company, subsidiary of Consumers Petroleum Company, has announced new oil storage facilities to handle 250,000 bbl. Now in operation, the 8-acre plant in Chicago is expected to help relieve the oil storage shortage in the winter months.

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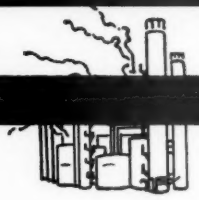


● **GASOLINE PLANT SCHEDULED BY STANOLIND.** Plans have been completed for the construction by Stanolind Oil and Gas Company of a gasoline plant in the Hugoton field, Kansas, for recovery of natural gasoline and butane, E. F. Bullard, president of Stanolind, announced. Construction will start within the next 60 days and will be completed this fall.

Residue gas from the plant will be sold to the Cities Service Gas Company. The plant will be built near Ulysses, Grant County. It is designed to process 100,000,000 cu ft per day with a peak capacity of 150,000,000 cu ft per day. Gas will be processed from 200,000 acres in the western part of the Hugoton field. The plant will be initially connected to 107 wells and will later be extended to 311 wells. Approximately 26,000 gal per day of natural gasoline and 36,000 gal per day of butane and propane will be produced by the plant.

● **CHEMICAL PLANT NEARLY COMPLETE.** McCarthy Chemical Company's new chemical processing units at Winnie, Jefferson County, Texas, are scheduled to start operations early in 1948. The units, which adjoin McCarthy's refinery and gasoline plant, will produce aromatic and unsaturated hydrocarbons as well as secondary products, such as formaldehyde. At this time, plans are being made to produce first benzene and ethylene with other hydrocarbons to follow.

Other units will continue to be added as building materials are available until all units are in operation by early 1949. Butane, propane, and refinery products will also be marketed in much greater quantities when these plant additions are completed.

Currently McCarthy's gasoline plant is processing about 100,000,000 cu ft of gas daily. By late 1948, it is anticipated the flow will have increased to approximately 250,000,000 cu ft a day. The Winnie installations represent an investment of some $15,000,000.

● **NEW SYNTHETIC RUBBER PRODUCTS.** Phillips Petroleum Company is producing on pilot-plant scale two new types of synthetic rubber, Philprene A, asserted to be superior for tire treads to natural rubber as well as to the synthetic rubbers now being produced, and Philprene B, which promises to be a replacement for natural rubber in tire carcasses.

In its latex or liquid form, Philprene synthetic rubber shows great promise for use in industry as a replacement for a portion of natural rubber latex. Estimates of plant production costs of Philprene A are approximately the same as for the regular GR-S type of synthetic rubber. Philprene B costs are expected to be only slightly higher, the company said.

● **PANTEPEC AND CREOLE TO COMPLETE TWO UNITS.** An accelerated program of development of Pantepec Oil Company's properties in Venezuela has been announced by C. U. Daniels, president. The company has arranged for $6,000,000 credit to finance the project.

The program includes: (1) completion in the Mulata field of a stabilization and repressuring plant now under joint construction with Creole Petroleum Corporation and scheduled for immediate operation; (2) completing preliminary plans for the construction, jointly with Creole Petroleum Corporation, of a stabilization plant to serve the El Roble field, and (3) large scale drilling operations, currently in progress, in both the Mulata and El Roble fields.

With the current crude oil demand and price structure, Mr. Daniels said the Pantepec management feels that the accelerated program of capital expenditures is required in the best interests of the company. The stabilization plants, he continued, will materially increase the volume of crude oil produced and improve the quality of the production. It is estimated, he said, that the repressuring part of the program alone will increase ultimate recovery of oil from the Mulata field by a substantial percentage. Results of the program, he said, are expected to increase earnings of the company substantially.

● **RESEARCH LABORATORIES TO OPEN.** Standard Oil Company (New Jersey) will open two new laboratories in the near future. The new laboratory being built at Baton Rouge, Louisiana, is ready for occupancy. The first of a group of new buildings at Linden, New Jersey, for Standard Oil Development Company, central research affiliate, will be completed this spring.

The research is partially devoted to the eventual production of high quality synthetic gasoline, diesel fuels, and chemicals from natural gas and coal, planning which looks to a possibility that synthetic fuels will ultimately be needed to supplement the nation's oil reserves. Application of the fluid catalyst technique to making liquid fuels and chemicals from natural gas is now being studied in a large pilot plant at Baton Rouge.

● **NEWS BRIEFS.** The Consumers Co-Operative unit at Coffeyville, Kansas, has let a contract to install new dewaxing unit at the refinery, which runs on crude from Northern Oklahoma and Eastern Kansas. The plant, originally built by the National Refining Company, has been operated by the Co-Ops for some time.

The West Tulsa refinery of The Texas Company has completed 1,253,000 man-hours without a disabling accident, a plant run of 785 days. Company has been granted the API's "million man-hours" certificate and the distinguished service award and pennant of the National Safety Council. E. M. Reynolds is plant superintendent.

● **PETROL BUYS SECOND PLANT.** A government-owned chemical plant in Beaumont, Texas, operated during the war by the Magnolia Petroleum Company for the production of nitration grade toluene, has been sold for $360,000 to the Petrol Terminal Corporation, Philadelphia, Pennsylvania, WAA announced.

The plant's distillation equipment with a crude topping capacity of about 30,000 bbl per stream day will be moved from Beaumont to a Texas City, Texas, refinery, also recently purchased by the Petrol Terminal Corporation. The Texas City refinery, formerly operated by the Southport Petroleum Company of Delaware, began operations December 13. It has a present capacity of 27,000 bbl a day. Reconstruction is still in progress.

● **SPEED WORK ON FRENCH PLANT.** After the French Government licensed the rebuilding of the refinery of the Raffineries de Petrole de la Gironde at Bec d'Ambes, near Bordeaux, France, steps were taken to speed the engineering and construction. The refinery of this Caltex affiliate was heavily damaged by bombings in 1940 and 1944, and its 8000-bbl per day production facilities have been completely out of operation. The new refinery will have a capacity of 14,000 bbl per day of gasoline, kerosene, diesel, and fuel oils. The facilities will include thermal reforming and chemical treating.

G. H. Zarafanetis of Arthur G. McKee and Company, which holds the construction contract, sailed from New York for France last month. As construction superintendent he will stay in France probably until the refinery is completed about early 1950. E. L. Howard, Caltex design engineer, has been in France since October purchasing materials and supervising on the ground design of facilities. Shortages of steel and equipment may delay the start of operations beyond the scheduled date. This refinery will provide petroleum products for distribution generally throughout Southwestern France.

This is the second recent announcement of refinery construction by Caltex affiliates in Europe. Two months ago announcement was made of the start of construction of a 22,500 bbl per day refinery near Rotterdam, Holland, by Caltex Petroleum Maatschappij (Nederland) N. V., which will cost approximately $18,000,000 and is scheduled for completion about the early part of 1950. The Caltex construction engineer in charge of the Holland project is F. W. Regan. The design work in New York for both refineries was headed by F. W. Dittus, chief engineer.

THE Petroleum Engineer
JANUARY, 1948

1947 oil discoveries largest since 1937

By H. J. STRUTH,* *Petroleum Economist*

COMPENSATORY oil prices, needed to offset excessively high costs involving the search for oil, induced the drilling in 1947 of the largest number of exploratory wells in the oil industry's history and resulted in the discovery of the greatest quantity of new reserves since 1937.

EXCLUSIVE

The search for new oil fields in 1947 topped all previous efforts when a total of 10,866 exploratory wells were drilled. This compares with 9548 in 1946 and 7618 such wells drilled in 1944. Wildcat wells totaled 5201 in 1947, against 4615 in 1946 and 3848 in 1944. New reserves discovered in 1947 aggregated about 1,860,000,000 bbl, against 1,558,000,000 bbl in 1946 and only 1,231,000,000 bbl in 1944. New oil discoveries last year exceeded by 1,081,000,000 bbl the quantity credited to the war year 1942, when oil prices were frozen at sub-normal levels. Last year's new oil discoveries have not been equaled or exceeded since 1937.

Conservative estimates, based upon careful studies of potentialities of new fields found in 1947 and reappraisal of numerous fields opened to development over the last eight years, indicate the likelihood that total additions to underground oil reserves in 1947 were in the order of at least 3,260,000,000 bbl. This is the greatest addition to reserves since 1937, when the total reported by the API Committee on Reserves amounted to 3,723,028,000 bbl.

In response to the greatest demand for oil in the history of the industry, and under the influence of improved prices, production of crude oil and raw condensates reached the record-breaking total of 1,865,000,000 bbl in 1947. Of far-reaching importance to the petroleum industry and the public is the fact that it was possible not only to meet the record breaking demand by domestic and foreign sources, but also to increase the underground inventory of reserves by a total of 1,395,000,00 bbl. Only in 1938, when production was 652,000,000 bbl less than in 1947, the net addition to underground reserves was greater. The credit balance of last year places the underground reserve inventory of oil on January 1, 1948 at approximately 23,344,000,000 bbl.

Drilling and overhead costs of exploratory wells, including wildcat oil producers and all dry holes exclusive of service wells, incurred an average cost last year of $88,100 per well. This represents about the average per well over the last three years and is slightly less than the cost of exploratory wells drilled in 1944. Drilling cost was the highest in the industry's history, averaging last year about $48,750 per well, including dry holes. Since 1935 drilling costs have been quadrupled. Wildcat drilling costs in 1947 averaged about $66,000 per well, including dry holes. In 1935 the cost of drilling an exploratory well was only

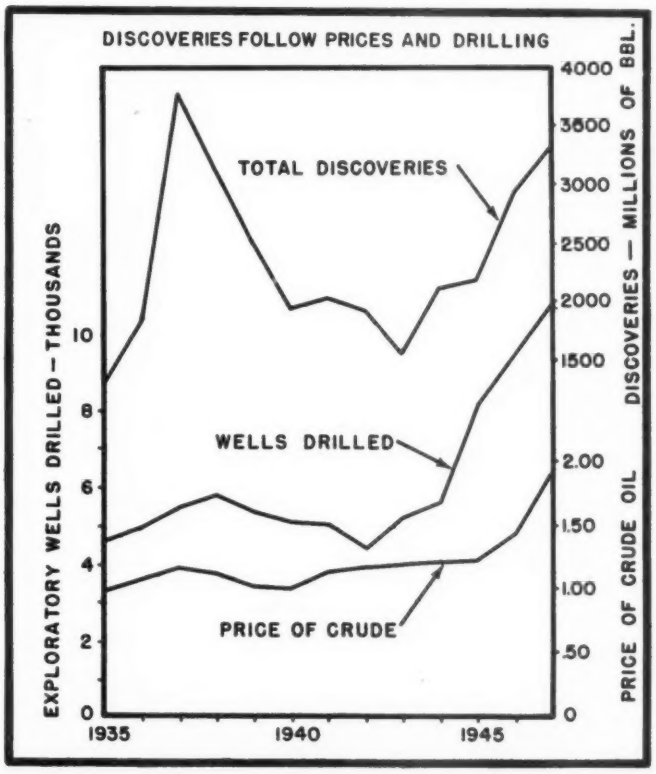


FIG. 1. Higher priced opened way to more exploratory drilling and to greater discoveries.

*Editor, *The Petroleum Data Book.*

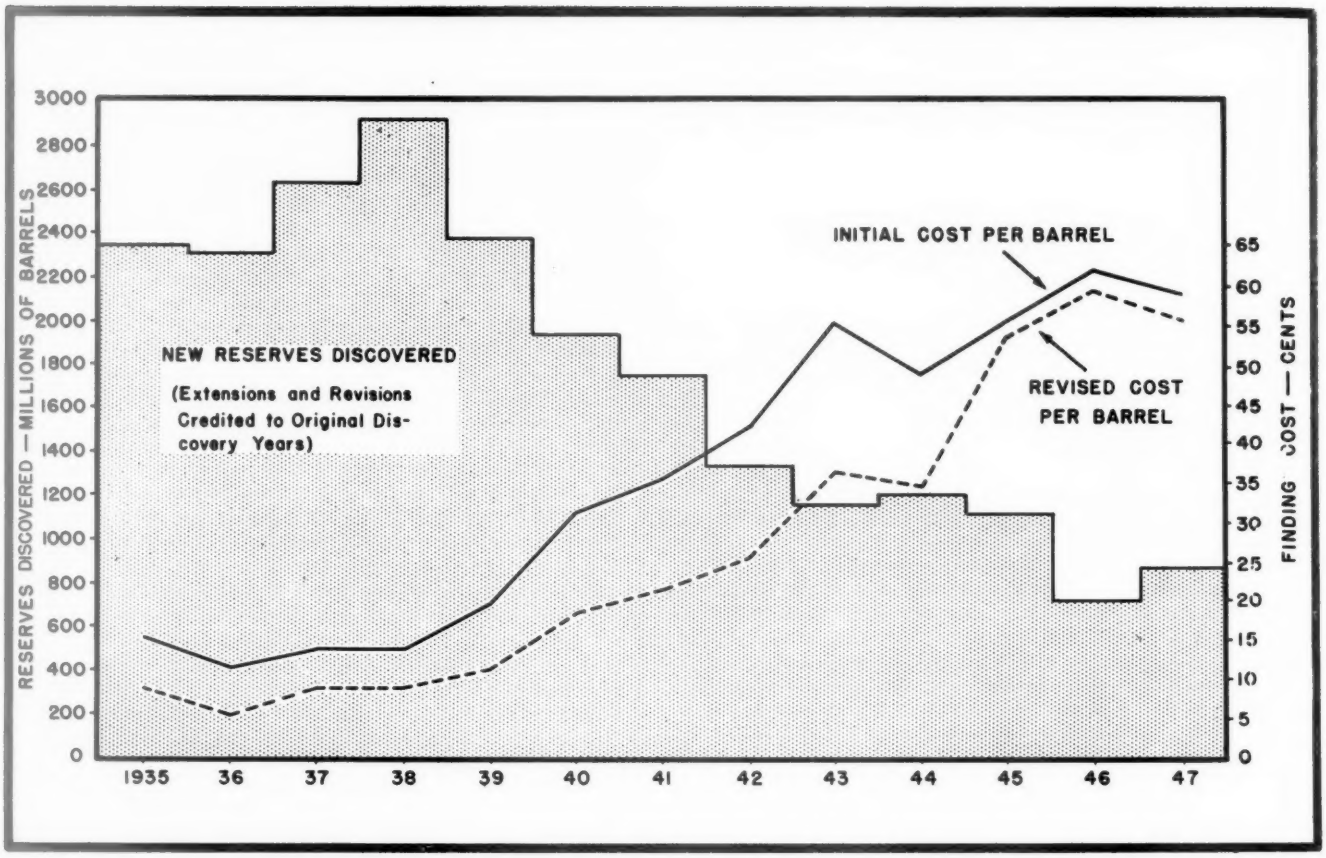

RESERVES DISCOVERED — MILLIONS OF BARRELS
FINDING COST — CENTS
INITIAL COST PER BARREL
REVISED COST PER BARREL
NEW RESERVES DISCOVERED
(Extensions and Revisions Credited to Original Discovery Years)
1935 36 37 38 39 40 41 42 43 44 45 46 47

FIG. 2. Reversal of downward trend in new and allocated discoveries arrested uptrend in finding costs last year. Revised finding cost is likely to show further reduction in 1948, due to revisions in first estimates.

FIG. 3. Replacement costs are five times greater than prewar—50.6 cents against 10.1 cents per bbl. Oil discovery credits of 1935-41 that cost $657 million involve a replacement cost of $3,294 million.

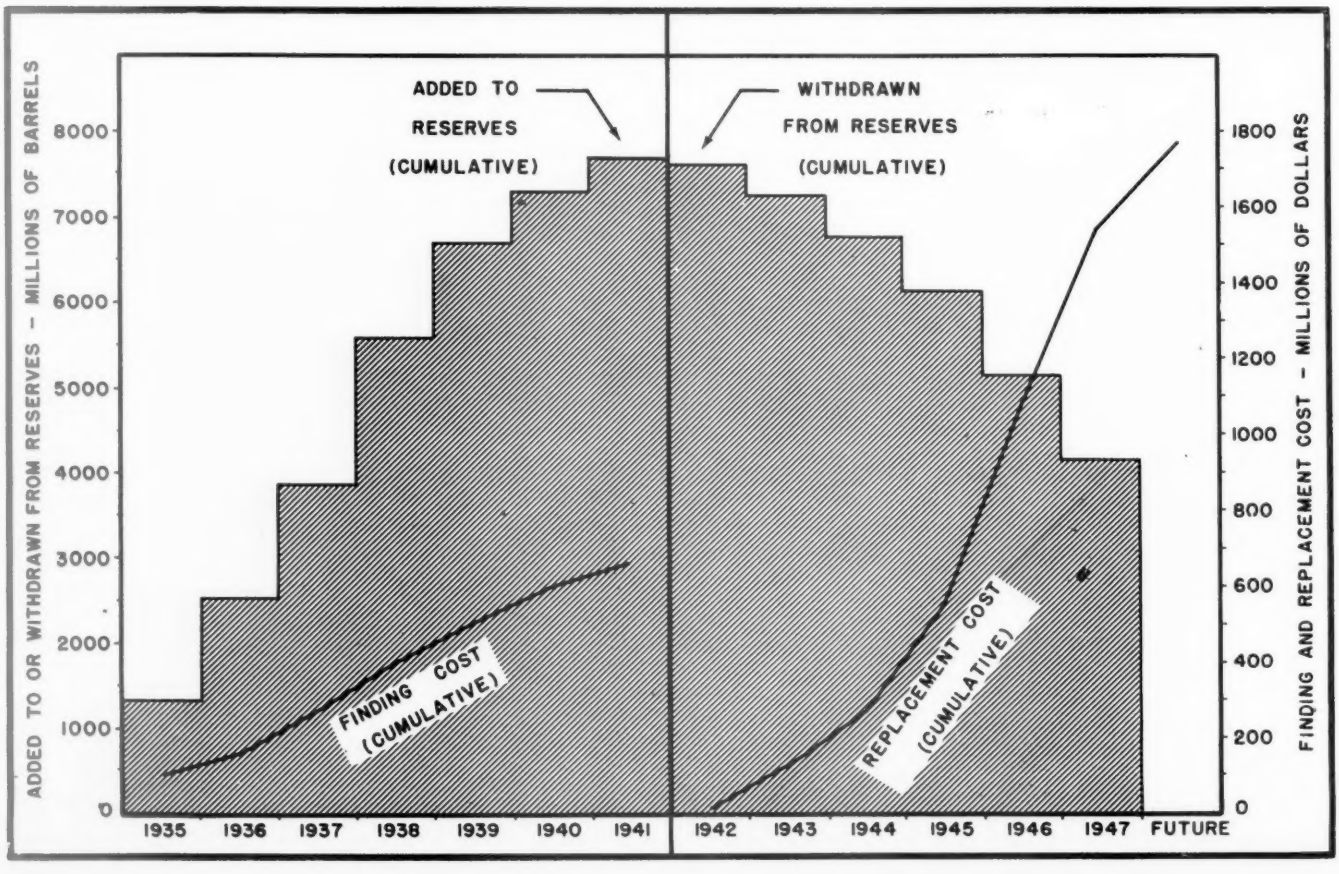

ADDED TO OR WITHDRAWN FROM RESERVES - MILLIONS OF BARRELS
FINDING AND REPLACEMENT COST - MILLIONS OF DOLLARS
ADDED TO RESERVES (CUMULATIVE)
WITHDRAWN FROM RESERVES (CUMULATIVE)
FINDING COST (CUMULATIVE)
REPLACEMENT COST (CUMULATIVE)
1935 1936 1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 FUTURE

TABLE 1. 1947 exploratory expenditures.

(Preliminary estimates)

Drilling cost—including equipment of productive wells	$ 518,850,000
Cost of acquiring and carrying leases, including land departments	290,100,000
Geological and geophysical cost	66,900,000
Overhead and general office expense	61,910,000
Grand total	$ 937,760,000
Total exploratory wells drilled*	10,643
Average drilling cost per well	$ 48,750
Average total cost per well	$ 88,100
Reserves discovered: (bbl)	
New fields	525,000,000
Extensions to previous discoveries†	1,335,000,000
Total discoveries	1,860,000,000
Working interest (85.5 per cent)	1,590,000,000
Initial cost per bbl	$ 0.59

*Includes productive wildcats, all dry holes, excludes service wells and wildcat gas wells.

†Does not include revisions in previous estimates amounting to about 1,400,000,000 barrels.

Note: Cost shown are proportions charged to oil exploration only. They do not include costs chargeable to developed leases nor costs of drilling oil and gas wells or service wells in proved producing areas. Wildcat gas well drilling and other charges have also been excluded.

TABLE 2. Exploratory wells drilled and price of crude oil.

Year	Price of crude	Exploratory wells drilled*
1935	$0.97	4,606
1936	1.09	4,948
1937	1.18	5,447
1938	1.13	5,765
1939	1.02	5,312
1940	1.02	5,085
1941	1.14	5,022
1942	1.19	4,363
1943	1.20	5,156
1944	1.21	5,601
1945	1.22	8,187
1946	1.43	9,403
1947(P)	1.95	10,643

Summary of data—annual basis.

1935-38	$1.09	5,191
1939-42	1.09	4,925
1943-46	1.30	7,111
1947(P)	1.95	10,643

*Excluding wildcat gas wells and service wells reported as dry holes.

(P)–Preliminary.

$12,310 whereas the total cost, including leases, exploration and overhead, was about $34,600. Attention is called here to revisions in drilling and overhead costs due to inclusion since 1935 of service wells, which should not have been classed as dry holes drilled. This has necessitated revised drilling and overhead costs of exploratory wells and consequent revisions in oil finding costs. The trends, however, remain the same as before.

On a working interest basis new oil discovered last year exclusive of revisions in previous estimates incurred an average initial finding cost of about 59 cents per bbl. This marked a slight reduction from 1946, when the cost was about 62 cents per bbl. Relatively larger discoveries last year raised the ultimate recoverable reserves per exploratory well and had the effect of slightly reducing the initial finding cost. Subsequent upward revisions in first estimates are expected to reduce further the 1947 finding cost to about 55.7 cents per bbl. Compared with 1935, however, last year's revised cost of finding oil is six times greater.

The effect of oil prices upon drilling operations is perhaps best demonstrated by plotting the net oil exploratory drilling figures with oil prices between 1935 and 1947. A most remarkable correlation is effected by grouping annual exploratory well totals with the annual average prices of crude oil for four-year periods.

This shows that when the price of crude oil averaged $1.09 per bbl, between 1935 and 1942, the number of exploratory wells drilled averaged between 4925 and 5191. When crude prices were increased to an average of $1.30 per bbl the number of exploratory wells drilled increased to 7111. In the year 1947 when the average price of crude had advanced to $1.95 per bbl the number of exploratory wells drilled in the search for oil reached the record-breaking total of 10,643. Price has definitely proved the influential factor in exploration activities over the last 13 years. More exploration and greater reserves discoveries might well have been experienced during the war years, when oil prices were frozen while all costs were permitted to rise to levels that discouraged the investment of venture capital.

Highly encouraging to wildcatters last year were the returns shown by the completion of productive wells. While there

TABLE 3. Drilling and exploratory results, 1944-1947.

	1947(P)	1946	1945	1944
Wildcats:				
Oil wells (new discoveries including new pays)	655	498	427	380
Oil wells (extensions)	131	141	114	113
Gas wells	223	145	130	115
Dry holes	4,192	3,831	3,434	3,240
Total wildcats	5,201	4,615	4,105	3,848
Development dry holes	5,665	4,933	4,212	3,770
Total exploratory wells	10,866	9,548	8,317	7,618
Development oil wells	17,875	14,771	13,921	12,536
Development gas wells	3,335	3,093	2,595	2,952
Total wildcat and development wells drilled	32,076	27,412	24,833	23,106
Service input wells drilled	2,314	2,242	2,212	2,156
Total wells drilled	34,390	29,654	27,045	25,262
Discoveries:				
Oil wells completed	655	498	427	380
New oil discovered (million bbl)	525	349	420	511
Average per well (thousand bbl)	800	701	984	1,345
Extensions*:				
Oil wells completed	131	141	114	113
New oil discovered (million bbl)	1,335	1,209	1,115	720
Average per well (thousand bbl)	10,190	8,575	9,780	6,372
Composite (wildcats):				
Oil wells completed	786	639	541	493
New oil discovered (million bbl)	1,860	1,558	1,535	1,231
Average per well (thousand bbl)	2,365	2,440	2,835	2,495
Total exploratory wells†	10,643	9,403	8,187	7,503
New oil discovered (million bbl)	1,860	1,558	1,535	1,231
Average per exploratory well (thousand bbl)	175	166	187	164

(P)–Preliminary estimates.
*Revisions in first estimates credited to original discovery years
†Excludes wildcat gas wells.

TABLE 4. Approximate cost of finding oil in the United States.

(Barrels in millions—money in thousands) (Revised 1947—excludes service wells)

Year	Initial reserves discovered (a)	Working interest (85.5%) (b)	Revised reserves discovered (e)	Working interest (85.5%) (d)	Exploratory wells drilled* (e)	Total drilling cost (f)	Lease and overhead cost (g)	Total cost (h)	Initial cost per bbl (cents) (h÷b)	Revised cost per bbl (cents) (h÷d)	Cost per well: Drilling (f÷e)	Cost per well: Total (h÷e)
1935	1,220	1,043	2,050	1,753	4,606	$56,702	$102,720	$159,422	15.3	9.1	$12,310	$34,600
1936	1,763	1,507	3,770	3,223	4,948	62,257	111,120	173,377	11.5	5.4	12,580	35,000
1937	1,929	1,649	2,975	2,544	5,447	82,995	147,150	230,145	14.0	9.0	15,235	42,250
1938	1,854	1,585	2,860	2,445	5,765	80,580	139,600	220,180	13.9	9.0	13,975	38,200
1939	1,450	1,240	2,511	2,157	5,312	87,763	156,750	244,513	19.7	11.4	16,520	46,000
1940	1,020	872	1,741	1,489	5,085	98,166	175,110	273,276	31.3	18.4	19,305	53,750
1941	980	838	1,630	1,394	5,022	119,160	180,600	299,760	35.8	21.5	23,730	59,690
1942	779	666	1,290	1,103	4,363	116,726	164,850	281,576	42.3	25.5	26,750	64,830
1943	862	737	1,307	1,117	5,156	165,045	244,646	409,685	55.6	36.7	32,000	79,460
1944	1,231	1,052	1,741	1,489	5,601	240,479	277,180	517,659	49.2	34.8	42,935	92,400
1945	1,535	1,312	1,605	1,372	8,187	365,557	365,650	731,207	55.7	53.3	44,650	89,300
1946	1,558	1,332	1,623	1,388	9,403	420,386	405,800	826,186	62.0	59.5	44,700	87,860
1947(P)	1,860	1,590	1,970†	1,684†	10,643	518,850	418,910	937,760	59.0	(s)55.7	48,750	88,100
Summary—four-year totals												
1935-38	6,766	5,784	11,655	9,965	20,766	282,534	500,590	783,124	13.5	7.9	13,600	37,700
1939-42	4,229	3,616	7,172	6,133	19,782	421,815	677,310	1,099,125	30.4	17.9	21,320	55,560
1943-46	5,186	4,433	6,276	5,366	28,447	1,191,467	1,293,270	2,484,737	56.1	46.3	41,885	87,350
1944-47	6,184	5,286	6,939	5,933	33,834	1,545,272	1,467,540	3,012,812	57.0	50.8	45,670	89,050

(P)–Preliminary.
*Service wells and wildcat gas wells excluded.
†Provides for subsequent upward revisions.
(a) New field discoveries and extensions to previously discovered fields. (Revisions allocated to back years.)
(e) Includes subsequent revisions in first estimates.
(e) Wildcat oil wells and all dry holes, excluding service wells.
(f) Costs include equipping wildcat oil producers.
(g) Includes lease, geological, geophysical, and overhead costs.
(s) Projected to reflect revisions expected in first estimates.

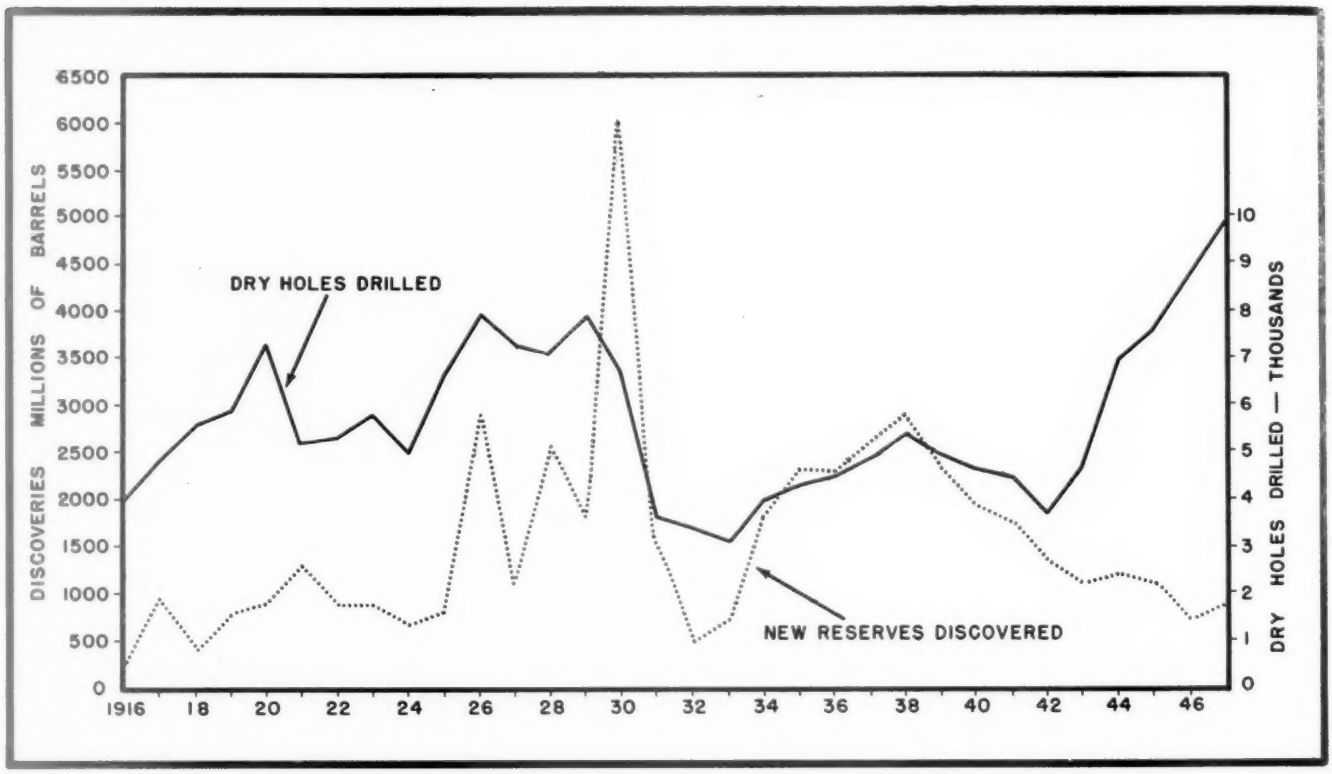


FIG. 4. It took 12 dry holes to lead to discovery of a million bbl in 1946-47, against only 2 dry holes per million in 1926-30. Effort to find oil indicated by dry holes drilled is greatest in oil industry's history.

was improvement in the dry hole ratio, which dropped to 80.6 per cent, from 83.0 per cent in 1946 and 84.2 per cent in 1944; there was also notable improvement in the quantity of reserves found per well drilled. Wildcat discovery wells averaged about 800,000 bbl per well, while outpost wells successful in extending the areas of previously discovered pools proved additional reserves in place by an average per well of 10,190,000 bbl. All wells drilled in oil exploration last year, including dry holes, proved average reserves of about 175,000 bbl. All these averages are shown to be substantially larger than those recorded in 1946. Preliminary figures indicate more wells were completed, 34,390 including input wells, than have ever been drilled in the industry's history.

Although new oil field discoveries have not made sensational news during the last ten years, the facts show that revisions in first estimates of new fields and subsequent extensions to previously discovered pools are becoming an increasingly important factor in the nation's petroleum reserves outlook. Hundreds of new oil fields that are not considered of more than usual importance at the time of their discovery prove subsequently to contain far more reserves than was credited to them by initial estimates. Careful study of revisions and extensions of oil pools reveals substantial additions to reserves of a large number of such fields, retroactive over a period of from seven to eight years.

Such studies make it evident that first estimates of reserves found in new oil pools are not as a rule the full measure of ultimate recoverable reserves in place. Last year, for example, new field discoveries accounted for about 525,000,000 bbl of new reserves, but extensions and revisions of previously discovered pools added about 2,735,000,000 bbl to proved reserves. Part of this huge addition to reserves was credited to fields discovered as far back as 1939. A substantial quantity of such retroactive reserve discoveries was credited to deeper producing zones and multiple zone formations encountered by drilling in fields that have been under development for a number of years.

The effect of retroactive credits to previously discovered fields by revisions in first estimates is shown in Table 4. In 1936, for example, new field discoveries and extensions to older fields were initially estimated at a combined total of 1,763,000,000 bbl. Yet, subsequent revisions over succeeding years increased the original estimates by more than 2,000,000,000 bbl, or 113 per cent. Even in 1942, when discoveries of new fields and extensions had declined to the low level of only 779,000,000 bbl, this figure was subsequently revised upward to a total of 1,290,000,000 bbl. Further upward revisions in 1942 reserves discoveries are expected subsequently to reach

TABLE 5. Replacement cost of petroleum reserves. (Revised 1947)

Year	New reserves discovered (million)‡	Oil produced (million)*	Surplus or short (million)	Working interest (85.5%) (million)	Adjusted finding cost (cents per bbl)	Total finding cost (thousands)
1935	2,325	997	+1,328	+1,133	9.1	$103,103
1936	2,305	1,100	+1,205	+1,030	5.4	55,620
1937	2,629	1,278	+1,351	+1,155	9.0	103,950
1938	2,920	1,213	+1,707	+1,450	9.0	130,500
1939	2,376	1,264	+1,112	+ 951	11.4	108,414
1940	1,936	1,352	+ 584	+ 499	18.4	91,816
1941	1,750	1,404	+ 346	+ 296	21.5	63,640
Total period of additions	16,241	8,608	+7,633	+6,514	10.1	$657,043
1942	1,345	1,385	— 41	— 35	25.5	8,925
1943	1,147	1,503	— 356	— 304	36.7	111,568
1944	1,202	1,678	— 476	— 407	34.8	141,636
1945	1,125	1,737	— 612	— 523	53.3	278,759
1946	714	1,740	—1,026	— 877	59.5	521,815
1947Ⓟ	875†	1,865	— 990	— 846	55.7	471,222
Total period of withdrawals	6,408	9,908	—3,500	—2,992	51.3	$1,533,925
Future to balance	..	..	—4,133	—3,522	50.0	1,761,000
Projected total	..	..	—7,633	—6,514	50.6	$3,294,925

*Crude oil and raw condensate.
‡Extensions and revisions credited to original discovery years.
†Provides for subsequent revisions in first estimates.
Ⓟ-Preliminary estimates.

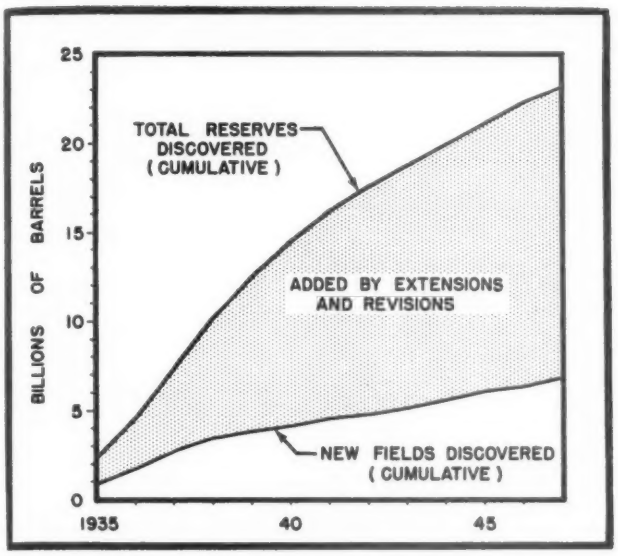


FIG. 5. Cumulative effect of revising original discoveries by extensions and revisions.

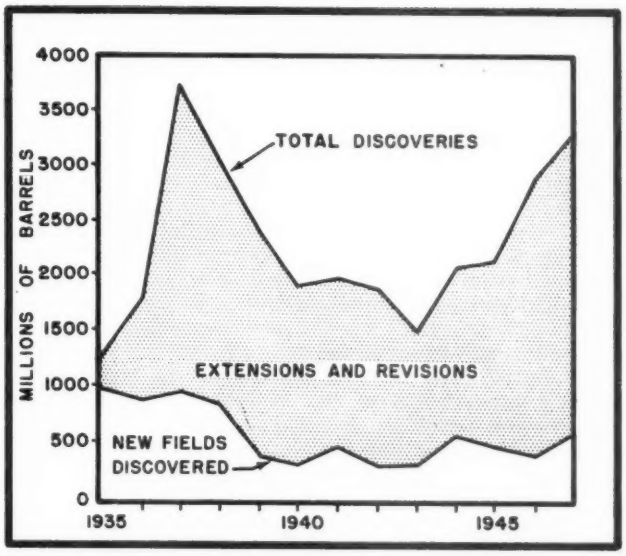


FIG. 6. Extensions and revisions, not allocated, were near the record made in 1937.

a figure more than double the initial discovery total.

In computing oil finding costs it is necessary to account for all oil discovered in new fields and by extensions to older fields, to be used as a divisor on a working interest basis. Costs are likewise computed for all productive wildcats and all dry holes drilled, exclusive of input wells, and these cover costs of both new fields and extensions to older fields. Revisions in first estimates, however, are credited to original discovery years and serve as credits to reduce initial finding costs. Summarized results of these studies by four-year periods show that the average initial finding cost between 1944 and 1947 was 57 cents per bbl.

Revisions in first estimates are shown to have reduced first costs to an average of about 50.8 cents per bbl. By comparison, the revised cost of finding oil in the period 1935-38 was 7.9 cents per bbl. These figures indicate that oil finding costs are now more than six times what they were in the pre-war period. Expenditures per exploratory well drilled in the last four years were $89,050 compared with $37,700 per well in the pre-war period. These figures offer full justification for price increases that have been initiated over the last two years.

Replacement costs of oil withdrawn from the underground inventory are now five times what they were between 1935 and 1941. In the pre-war period the average replacement cost of working interest oil reserves was 10.1 cents per bbl. Today, every net bbl of new oil discovered, to replace oil found in earlier years, entails an average cost of 50.6 cents. Between 1935 and 1941, the industry added to reserves a net total of 7,633,000,000 bbl, which represented a net cost of $657,043,000. To replace that same quantity of oil, subsequent to 1941, will have involved expenditures of $3,294,925,000.

By allocating extensions and revisions

TABLE 6. United States petroleum reserves situation. (Revised 1947) (Crude oil and condensates) (All barrels in millions)

Year	Reported reserve inventory January 1†	New field discoveries†	Extensions and revisions†	Total reserves added†	Production	Allocation of extensions and revisions	Plus new field discoveries†	Adjusted oil discoveries‡	Adjusted reserve inventory January 1
1935	12,177	950	270	1,220	997	1,375	950	2,325	19,211
1936	12,400	850	913	1,763	1,100	1,455	850	2,305	20,539
1937	13,063	929	2,793	3,722	1,278	1,700	929	2,629	21,744
1938	15,507	810	2,244	3,054	1,213	2,110	810	2,920	23,095
1939	17,348	341	2,058	2,399	1,264	2,035	341	2,376	24,802
1940	18,483	286	1,607	1 893	1,352	1,650	286	1,936	25,914
1941	19,024	430	1,539	1,969	1,404	1,320	430	1,750	26,498
1942	19,589	260	1,619	1,879	1,385	1,085	260	1,345	26,844
1943	20,083	282	1,262	1,484	1,503	865	282	1,147	26,804
1944	20,065	511	1,556	2,067	1,678	691	511	1,202	26,448
1945	20,453	420	1,690	2,110	1,737	705	420	1,125	25,972
1946	20,826	349	2,514	2,863	1,740	365	349	714	25,360
1947Ⓟ	21,949	525	2,735	3,260	1,865	350*	525	875	24,334
1948Ⓟ	23,344								23,344
Total 1935-47	..	6,943	22,740	29,683	18,516	15,706	6,943	22,649	

	Method A§	Method B‡
Reserves inventory January 1, 1935	12,177,000,000	19,211,000,000
Discoveries	29,683,000,000	22,649,000,000
Total	41,860,000,000	41,860,000,000
Production	18,516,000,000	18,516,000,000
Reserves inventory January 1, 1948	23,344,000,000	23,344,000,000

*Provides for subsequent extensions and revisions in estimates.
†By A.P.I. Reserves Committee—1947 estimated by author.
‡Crediting extensions and revisions to original discovery years.
§Crediting extensions and revisions currently.
Ⓟ–Preliminary estimates.

TABLE 7. Wildcat wells—oil discoveries.

Year	Total wildcat wells drilled*	Wildcat oil producers	Per cent oil producers	New reserves discovered† (million)	Average reserves discovered, all wildcats (thousands)	Average reserves discovered, wildcat producers (thousands)
1935	1,675	190	13.4	2,325	1,388	12,237
1936	1,950	215	10.3	2,305	1,182	10,721
1937	2,224	250	12 4	2,629	1,182	10,516
1938	2,638	260	9.9	2,920	1,107	11,231
1939	2,589	245	9.5	2,376	918	9,698
1940	3,038	300	9.9	1,936	637	6,453
1941	3,264	504	15.4	1,750	536	3,472
1942	3,045	408	13.4	1,345	442	3,297
1943	3,319	432	13.0	1,147	346	2,655
1944	3,848	493	12 8	1,202	312	2,438
1945	4,105	541	13.2	1,125	274	2,079
1946	4,615	639	13.8	714	155	1,117
1947Ⓟ	5,201	786	15.1	875‡	168	1,113
Total	41,511	5,259	12.7	22,649	546	4,307

Ⓟ–Preliminary estimates.
*Includes gas wells.
†Revisions allocated to original discovery years.
‡Provides for subsequent upward revisions.

to original discovery years, it is seen that between 1935 and 1941 discoveries aggregated 16,241,000,000 bbl. Since 1942 the net additions to reserves by strictly new discoveries have amounted to 6,408,000,000 bbl. Although discoveries of recent years are subject to subsequent additions through extensions and revisions, it is obvious that the discovery of several major oil pools over the next several years would effect a reduction in the average cost of replacement. Under the intense exploration effort now in progress, the search for oil is more likely to be rewarded by substantial improvement in the discovery rate.

The method used by the author of crediting original oil pool discoveries with oil added by extensions and revisions has resulted in a build-up in the proved reserves inventory to an all-time peak of 26,844,000,000 bbl. By this method it is apparent that the peak reserves figure was established at the end of 1941. Since then, there has been a net withdrawal from reserves of 3,500,000,000 bbl. This is a decided improvement in the reserves picture from the war period, for extensions and revisions of the last two years have built up previous reserves to the extent of 5,249,000,000 bbl. In fact, during the last two war years total reserve additions amounted to only 761,000,000 bbl but the net increase in reserves of the last two years amounted to 2,518,000,000 bbl.

Studies of exploratory results over the last 13 years prove definitely that discovery rates have shown a substantial decline. In 1935, the average quantity of oil found per wildcat well drilled, including dry holes, was 12,237,000 bbl.

TABLE 8. Results of exploratory effort. (Revised 1947)

Year	Exploratory wells and dry holes drilled*	Reserves discovered			Wells per million barrels discovered	Reserves discovered per exploratory well (thousands)
		New fields (millions)	Extensions and revisions† (millions)	Total (millions)		
1935	4,606	950	1,100	2,050	2.2	445
1936	4,948	850	2,920	3,770	1.3	762
1937	5,447	929	2,046	2,975	1.8	546
1938	5,765	810	2,050	2,860	2.0	496
1939	5,312	341	2,170	2,511	2.1	473
1940	5,085	286	1,455	1,741	2.9	342
1941	5,022	430	1,200	1,630	3.1	325
1942	4,363	260	1,030	1,290	3.4	296
1943	5,156	282	1,025	1,307	3.9	253
1944	5,601	511	1,230	1,741	3.2	311
1945	8,187	420	1,185	1,605	5.1	196
1946	9,403	349	1,274	1,623	5.8	173
1947(P)	10,643	525	1,445	1,970‡	5.4	185
Total	79,538	6,943	20,130	27,073	4.5	340

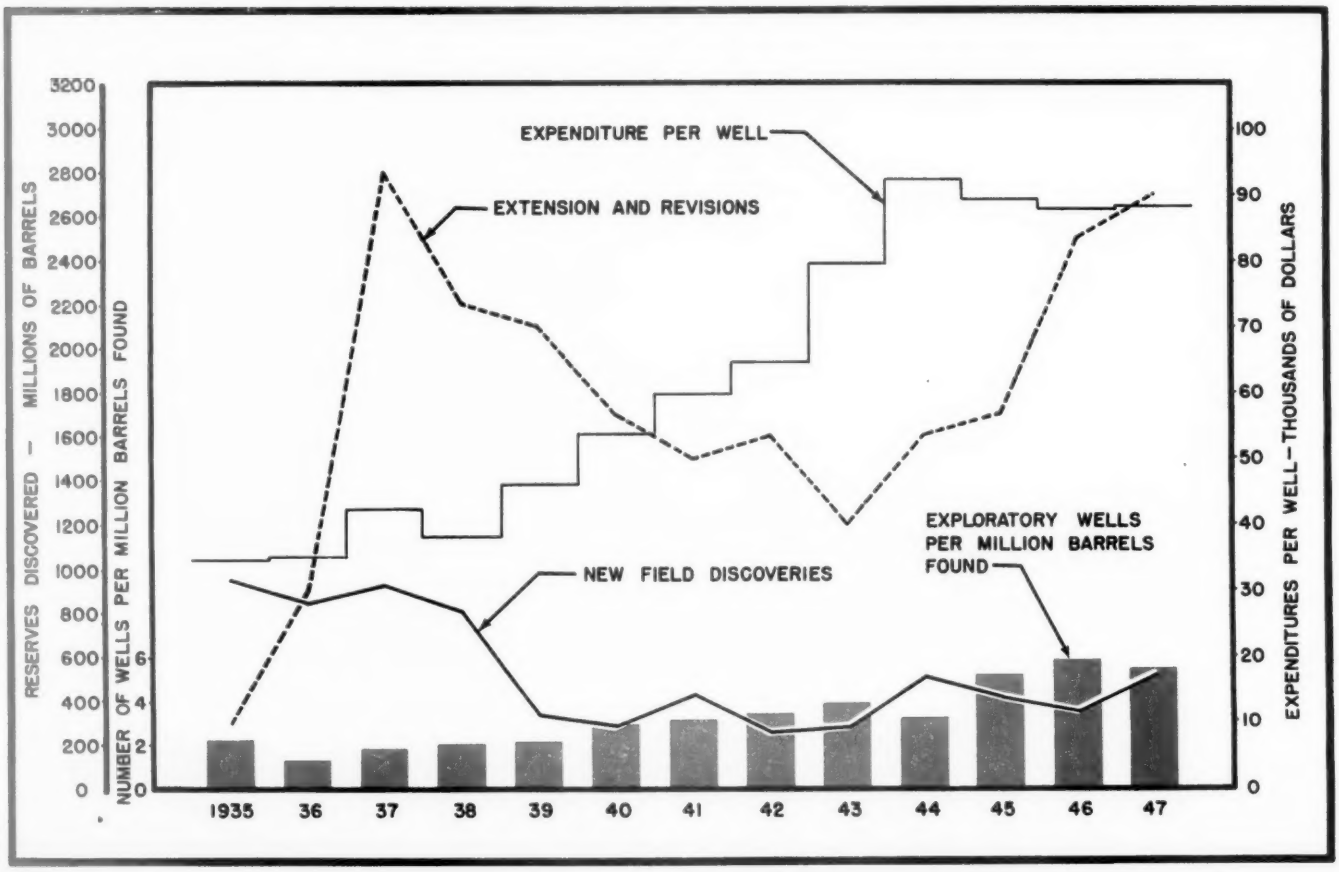
(P)–Preliminary estimates.
*Excludes service wells and wildcat gas wells.
†Revisions in estimates allocated to original discovery years—extensions are credited to current years.
‡Provides for subsequent upward revisions in first estimates.

TABLE 9. Reserve discoveries related to all drilling. (Annual averages)

Period	All wells drilled*	Oil wells completed	Reserves found (millions)	Average reserves discovered per well		
				All wells	Oil wells	Dry holes
1916–20	27,359	19,732	660	24,124	33,448	118,471
1921–25	23,715	15,872	920	38,794	57,964	163,381
1926–30	24,678	14,634	2,870	116,298	196,118	388,889
1931–35	15,625	10,595	1,385	88,640	130,722	374,527
1936–40	27,477	18,997	2,433	88,547	128,073	496,429
1941–45	22,608	13,099	1,314	58,121	100,313	237,484
1946–47	29,744	17,035	795	26,728	46,669	85,392

*Excluding service wells.

FIG. 7. Greater discoveries have been accompanied by moderately lower expenditures per well. Increased development drilling, encouraged by higher prices, is expected to bring further reduction in unit costs.



In 1947 the discovery rate was only 1,113,000 bbl. Over the last 13 years the industry drilled a total of 41,511 wildcat wells, of which only 12.7 per cent were productive of oil. These wells resulted in the discovery of 22,649,000,000 bbl of new reserves, or an average of 4,307,000 bbl per well drilled. Productive wildcats during this period proved an average reserve per well of 546,000 bbl.

Over the last 13 years, it has required the drilling of 4.5 exploratory wells to find one million barrels of oil. The chances of success in finding oil fields however, have diminished considerably since 1936. In that year 1.3 wells were drilled for each million barrels of oil found, whereas in 1947 it took 5.4 wells to find the same quantity of oil. In the search for oil over this period the industry has drilled a total of 79,538 wells, excluding those that found natural gas. These wells proved new reserves totaling 27,073,000,000 bbl, or an average per well drilled, including dry holes, of 340,000 bbl.

The most successful period in discovery results was 1926-30, when the industry found total reserves averaging 2,870,000,000 bbl annually. During that period the average rate of oil discovery per well drilled, including all producers and dry holes, amounted to 116,298 bbl. By comparison, discoveries in 1946-47 averaged 26,728 bbl per well. In the last two years the average rate of discovery per productive oil well drilled, including wildcats and development wells, was 46,669 bbl. In the period 1926-30, when Kettleman Hills, Oklahoma City, and

TABLE 10. Dry holes, reserves discovered, production—1916-1947 inclusive.
(Revised 1947)

Year	Dry holes drilled*	New reserves discovered† (millions)	Dry holes per million barrels	Annual production (millions)	Surplus or short (millions)	Reported reserves inventory‡ Dec. 31 (millions)	Adjusted reserves inventory, Dec. 31 (millions)
1916	4,039	250	16	301	— 51	5,900	5,290
1917	4,851	950	5	335	+ 615	5,900	5,905
1918	5,631	400	14	356	+ 44	6,200	5,949
1919	5,986	800	7	378	+ 422	6,700	6,371
1920	7,346	900	8	443	+ 457	7,200	6,828
Total 5 years	27,853	3,300		1,813	+1,487		
Annual average	5,571	666	8	363	+ 297		
1921	5,160	1,300	4	472	+ 828	7,800	7,656
1922	5,332	900	5	557	+ 343	7,600	7,899
1923	5,883	900	6	732	+ 168	7,600	8,167
1924	5,044	700	7	714	— 14	7,500	8,153
1925	6,734	800	8	764	+ 36	8,500	8,189
Total 5 years	28,153	4,600		3,239	+1,361		
Annual average	5,631	920	6	648	+ 272		
1923	7,965	2,900	4	771	+2,129	8,800	10,318
1927	7,210	1,100	6	901	+ 199	10,500	10,517
1928	7,078	2,550	3	901	+1,649	11,000	12,166
1929	7,914	1,800	4	1,007	+ 793	13,200	12,959
1930	6,734	6,000	1	898	+5,102	13,600	18,061
Total 5 years	36,901	14,350		4,478	+9,872		
Annual average	7,380	2,870	2	896	+1,974		
1931	3,609	1,600	2	851	+ 749	13,000	18,810
1932	3,469	500	7	785	— 285	12,300	18,525
1933	3,112	700	4	906	— 206	12,000	18,319
1934	4,012	1,800	2	908	+ 892	12,177	19,211
1935	4,286	2,325	2	997	+1,328	12,400	20,539
Total 5 years	18,488	6,925		4,447	+2,478		
Annual average	3,698	1,385	3	889	+ 495		
1936	4,573	2,305	2	1,100	+1,205	13,063	21,744
1937	4,971	2,629	2	1,278	+1,351	15,507	23,095
1938	5,355	2,920	2	1,213	+1,707	17,348	24,802
1939	4,937	2,376	2	1,264	+1,112	18,483	25,914
1940	4,670	1,936	2	1,352	+ 584	19,024	26,498
Total 5 years	24,506	12,166		6,207	+5,959		
Annual average	4,901	2,433	2	1,241	+1,192		
1941	4,519	1,750	3	1,404	+ 346	19,589	26,844
1942	3,772	1,345	3	1,385	— 40	20,083	26,804
1943	4,719	1,147	4	1,503	— 356	20,065	26,448
1944	7,010	1,202	6	1,678	— 476	20,453	25,972
1945	7,646	1,125	7	1,737	— 612	20,826	25,360
Total 5 years	27,666	6,569		7,707	—1,138		
Annual average	5,533	1,314	4	1,541	— 227		
1946	8,764	714	12	1,740	—1,026	21,949	24,334
1947Ⓟ	9,857	875§	11	1,865	— 990	23,344	23,344
Total 2 years	18,621	1,589		3,605	—2,016		
Annual average	9,310	795	12	1,802	—1,008		

*Excluding service wells.
†Extensions and revisions credited to years of original discovery.
‡Reported by A.P.I. Reserves Committee, 1946 and 1947 estimated by author.
§Provides for subsequent extensions and revisions of about 350 million barrels.
Ⓟ-Preliminary estimates.

FIG. 8. Upturn in discovery rate and slight reduction in wells per million bbl found are encouraging signs.

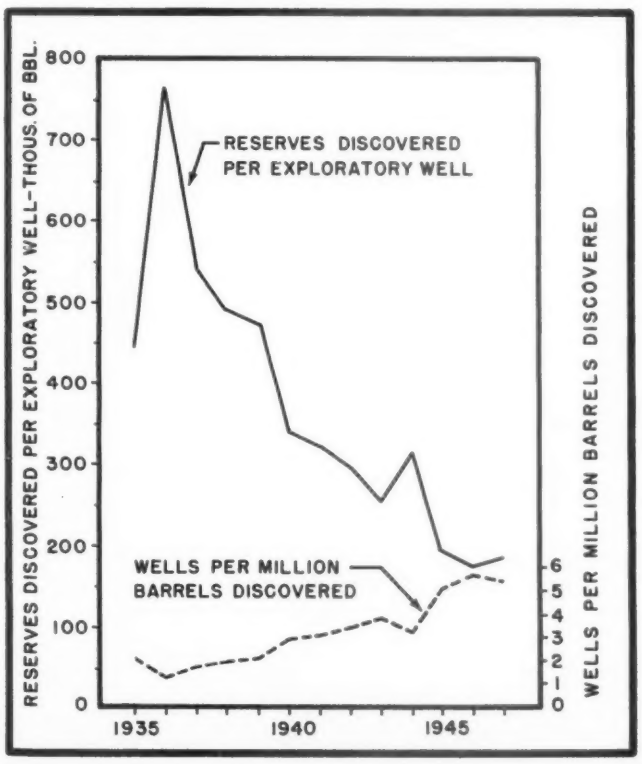
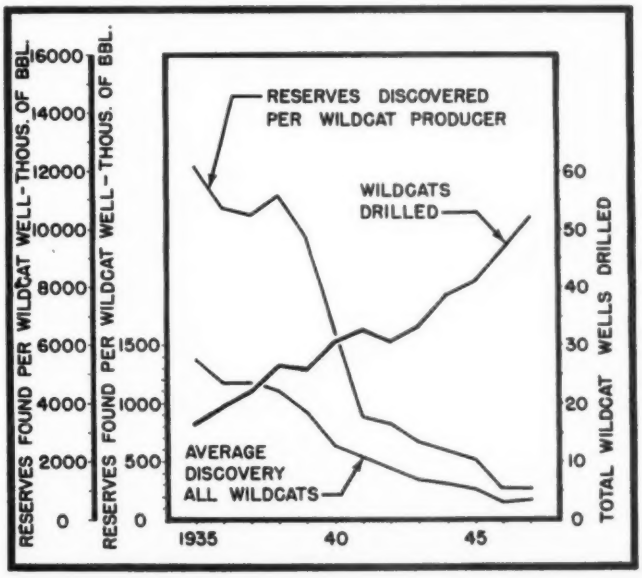


FIG. 9. More wildcats needed to offset smaller discovery rate.



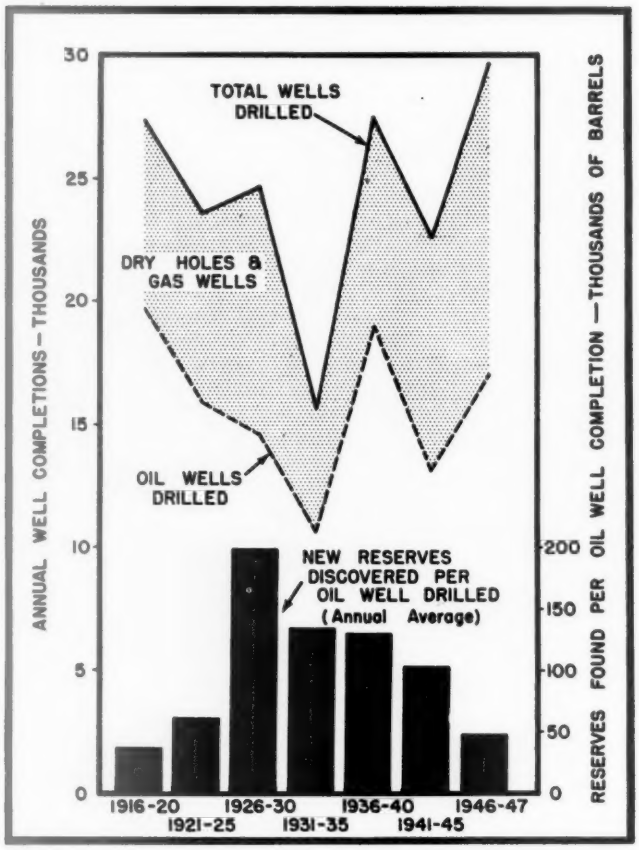


FIG. 10. Upturn in drilling to new peak points to continued uptrend in 1948 and prospect of material gain in new oil discoveries.

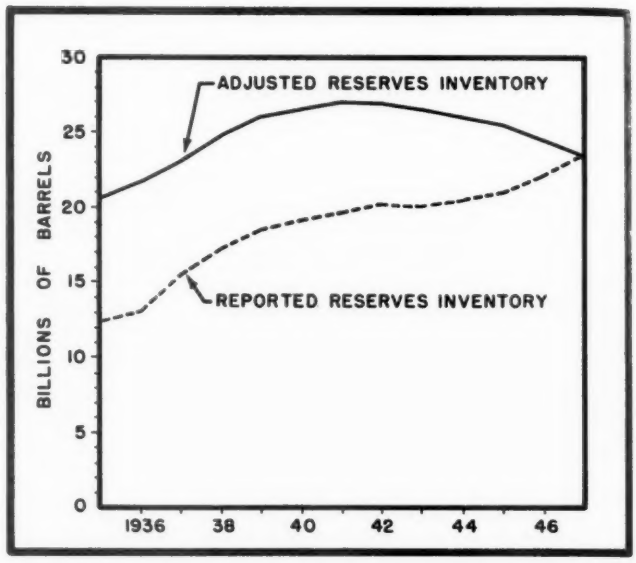


FIG. 11. Peak reserves inventory of 26,844,000,000 bbl was reached at end of 1941. Subsequent extensions and revisions will move it forward and higher.

East Texas were discovered, the rate per oil well completed was 196,118 bbl.

Dry holes drilled provide a reliable index of exploratory activity. Statistics for the last two years indicate that the largest number of dry holes was drilled in the industry's history. The annual average was 9310, compared with the preceding five-year annual average of 5533. The astounding fact is that in 1946-47 it was necessary to drill 12 dry holes for each million barrels of oil found, while the average in 1926-30 was only two dry holes per million. These facts emphasize the difficulties attending the search for oil today and the tremendous risk of capital involved. They reemphasize the high cost of replacement of reserves and leave no doubt of the justification for compensatory oil prices to offset greater costs of exploration.

Although complete information with respect to natural gas and gas liquids discoveries is not yet available for the year 1947, it is of interest to consider some preliminary facts. A study of the 1947 report of the Natural Gas Reserves Committee of the American Gas Association shows that total discoveries in 1946, including new fields, extensions and revisions, aggregated 17,729,152,000,000 cu ft. Analysis of 1946 drilling operations indicates that a total of about 368 productive wildcat wells contributed to the year's discoveries of natural gas, including gas that was associated with crude oil and condensates. This implies that discoveries credited to 1946 averaged roughly about 50,000,000,000 cu ft per productive well completed. By comparison, wildcat gas wells and oil wells completed in 1947, that were productive of natural gas, totaled approximately 498, of which 223 were discoveries of non-associated gas. If the discovery rate per well of 1946 was maintained last year, it is likely that natural gas discoveries were in the order of at least 25,000,000,000,000 (trillion) cu ft. If production last year amounted to 6,000,000,000,000 cu ft the net addition to underground reserves may have been about 19,000,000,000,000 cu ft. As reserves at the end of 1946 were placed by this committee at 160,000,000,000,000 cu ft, it is likely that the reserve inventory at the end of 1947 was in the order of 179,000,000,000,000 cu ft. These figures may vary with final estimates, but the facts indicate that the year 1947 was probably the most successful year in natural gas discoveries to date.

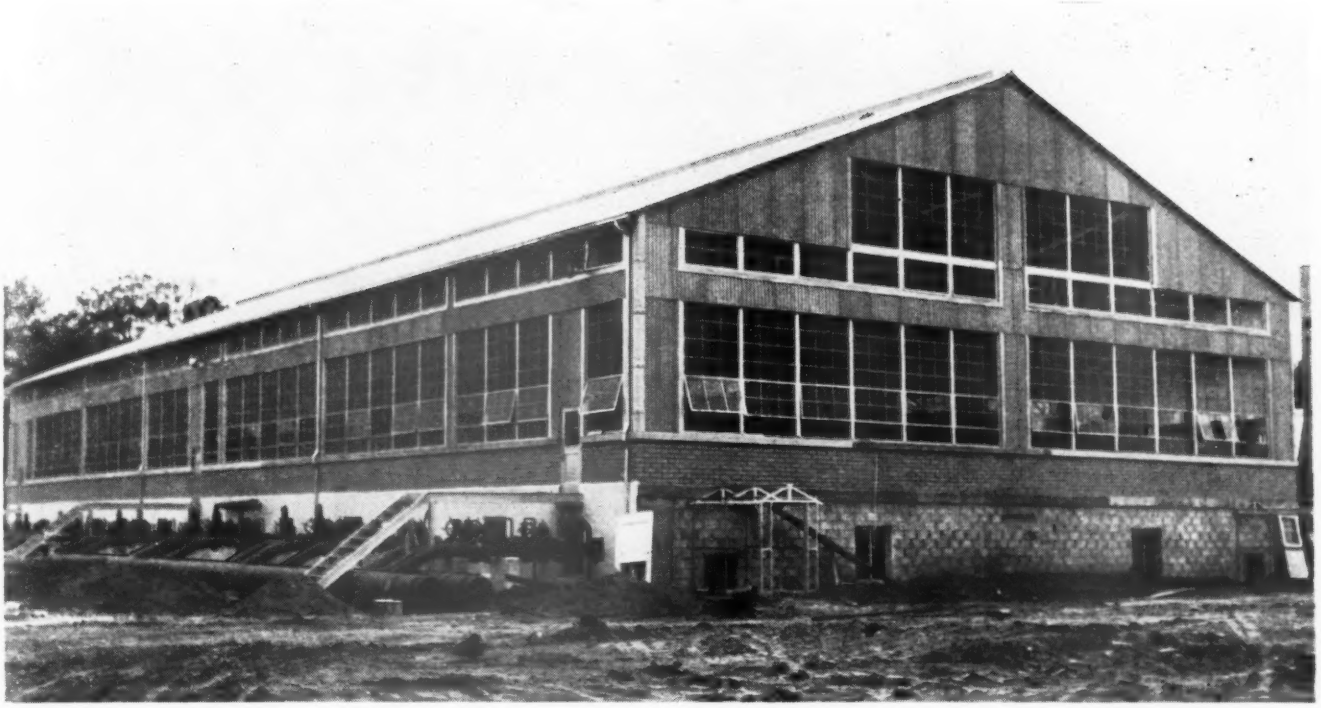
Relative to figures made available for 1946, it is also likely that additions to natural gas liquids reserves increased the underground inventory to perhaps 2,500,000,000 bbl. Natural gas reserves may be computed on an oil equivalent basis by a conversion factor of 10,000 cu ft per bbl. Natural gas reserves would therefore be the equivalent of about 17,900,000,000 bbl of oil. Summarizing all the known data leads to the conclusion that the total U. S. petroleum reserves on an oil equivalent basis are now in the order of about 43,744,000,000 bbl. The figure is made up as follows:

Oil and Equivalent	Total U. S. Reserves—Bbl
Crude oil and condensates	23,344,000,000
Natural gas (179 trillion cu ft)	17,900,000,000
Natural gas liquids	2,500,000,000
Total reserves	43,744,000,000

Despite the unprecedented rise in demand for petroleum and its products, there is little to sustain the contention of some who say the nation is running out of oil. Dividing reserves by the annual rate of production provides nothing in the way of a measure of the years of future supply available. Although the ratio of proved reserves to annual production may be 12.6, this does not mean that our underground supply of oil will be exhausted in 12.6 years. In 1922, the ratio was 10.4, but we have been producing oil at a constantly increasing rate over the last 25 years and still have a reserve supply underground of 23,344,000,000 bbl. If we divide the combined reserves of oil and gas by the annual rate of production we obtain a ratio of about 19.

This still does not mean that we will be out of oil and gas by 1966. Such figuring should be discouraged within and outside the petroleum industry. The search for oil and gas is expected to continue at an increasing rate for many years to come and there is every reason to believe that success will continue to attend such efforts. Every oil field brought in today is good for reserves that are materially greater than first estimates indicate. The full effect of discoveries made last year may not be measured conclusively until 1954 or 1955. Revisions and extensions hold the important key to our future oil supply.

★ ★ ★



Structural steel buildings are covered with corrugated transite roofing with siding of glazed green glass. Tile curb walls extend from floor line to bottom of windows. Tile is glazed inside and rough-cut outside, and was especially made for these stations.

Compressor stations add to line's capacity

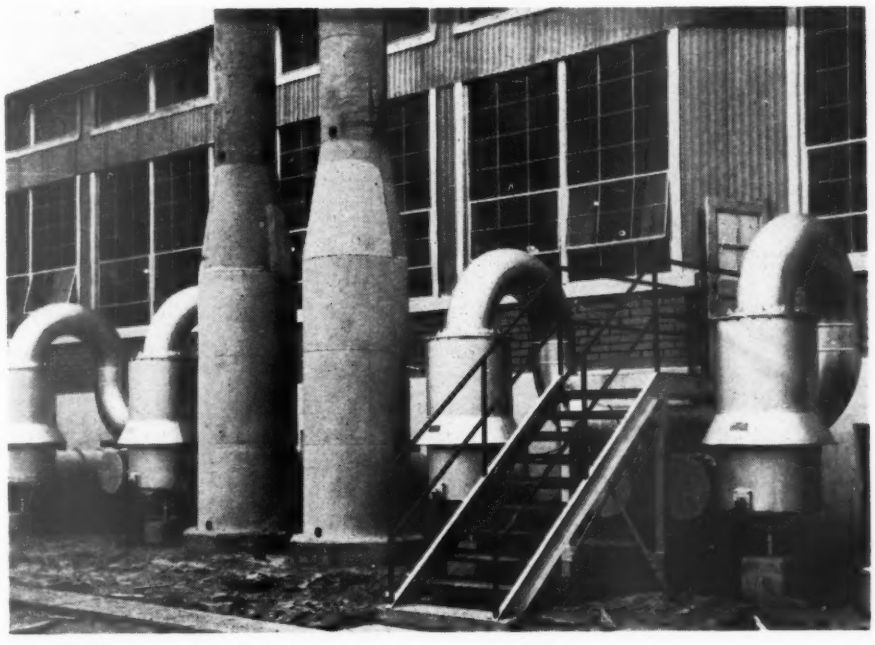
By FRANK H. LOVE, *Managing Editor*

SINCE the pipe line system of Tennessee Gas Transmission Company from South Texas to West Virginia was completed and first placed in operation in the fall of 1944 the company's policy has been one of continuous expansion. To the original system loops have been laid, extensions made, and new compressor stations added, greatly increasing the line's daily throughput.

EXCLUSIVE

Most recent completions in this program are three new stations—at Victoria and Fostoria, Texas, and Natchitoches, Louisiana. The compressors installed are 1600-hp horizontal units, six each at Fostoria and Natchitoches and three at Victoria. The stations were designed ultimately to handle 45,000,000 cu ft daily per engine at a suction pressure of about 490 psi and discharge pressure of 760 psi, operating single stage. Inlet gas to the stations is scrubbed before entering the compressor units and after being compressed is cooled by being passed through coils in the gas cooling tower before entering the mainline. Each station has two gas cooling units in each bay of

Air filters and exhaust mufflers for compressor units. In this building are housed six units. The photograph was taken at the Fostoria, Texas, station.



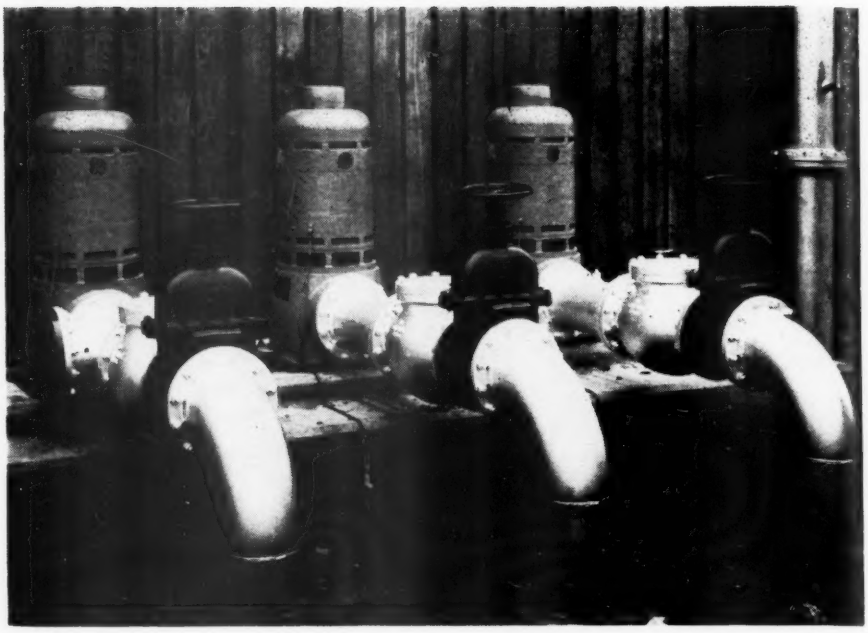
the tower, which are 24 ft long and six rows deep, single pass in series.

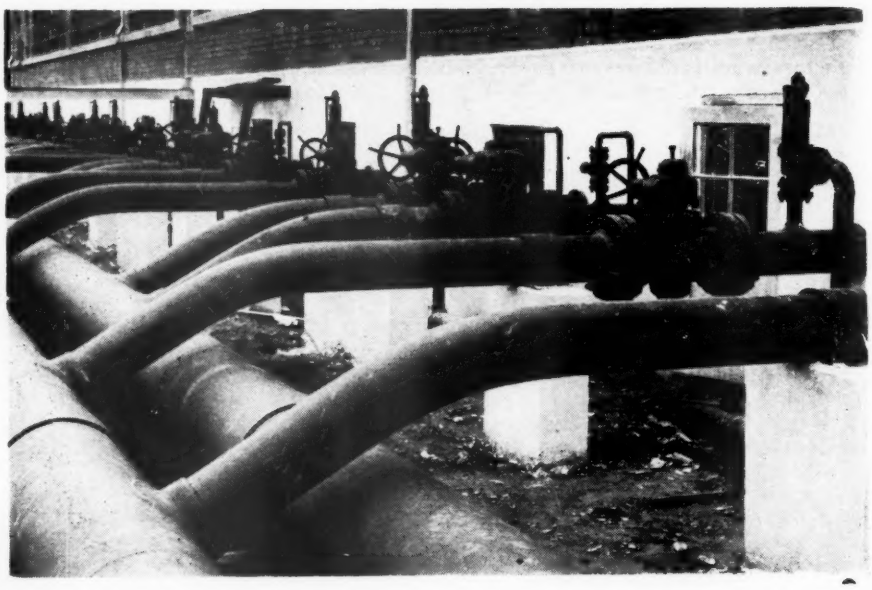
Gas piping bends in and out of the compressor cylinders are especially designed cast-steel installations. After being cast these bends were radiographed and tested to 1500 psi hydrostatic pressure. Special spring supports have been cast into the engine blocks to take the weight of bends and valves off the compressor flanges and snub out vibration.

● **Design station buildings.** Another feature of the stations are the design and construction of the buildings. All buildings are of structural steel covered with corrugated transite roofing and siding glazed with green glass, which minimizes glare but admits ample light. Buff colored tile curb walls extend from the floor line to the bottom of the windows. The tile is glazed inside and rough-cut outside and was especially made for these stations. Floors are of waxed red tile.

Main and auxiliary buildings have full basements with ample lighting. The main buildings receive their daytime lighting through swinging casement windows and basement doors. Basement walls and blocks are finished with white portland cement.

The main operating floors were poured by using tri-rib steel decking inverted to leave a smooth steel-clad finish in the basement ceilings, then painted with

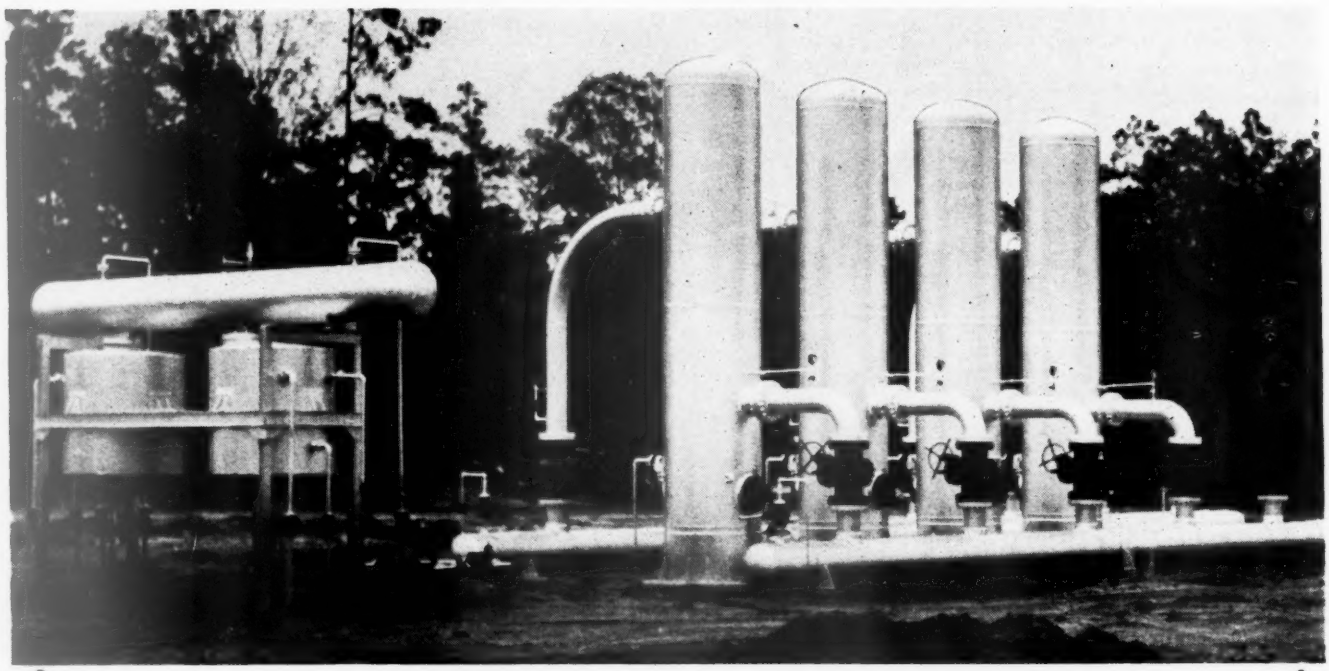




Top—These vertical pumps for pumping water over the cooling towers each has a capacity of 1900 gpm at 100 F. They are driven by 75-hp motors.

Right—This type of bend on compressor suction and discharge headers helps reduce vibration.

Below—Dirt and other foreign material is removed from the gas received at the stations by this type of scrubber.



aluminum for cleanliness and lighting effect.

In each main building two traveling cranes are provided for convenience in operation. A loading dock is provided in the main buildings at ground level to permit trucks to back under one of these cranes when moving heavy engine parts.

In the basement of each main compressor building specially designed lubricating oil filtering and conditioning equipment has been installed.

Descriptions of the essential features of the three stations follow:

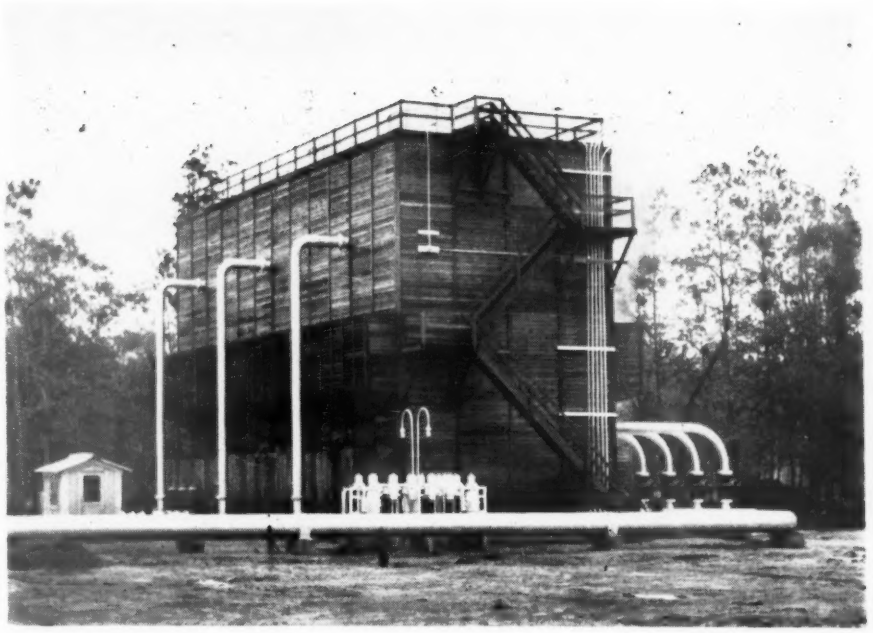
● **Station No. 1—Victoria, Texas.** The Victoria station is the smallest of the three. It contains three 1600-hp horizontal compressor units that have a 26-in. bore and 36-in. stroke. These are housed in a 103-ft 7-in. by 75-ft 11-in. building.

Two 370-hp, 400-rpm auxiliary engines driving 250-kw, 440-volt, 60-cycle generators provide plant electricity. The auxiliary building is 62 ft 4 in. by 51 ft 2¼ in. On a lower level in this same building are the circulating water pumps for engine cooling. These consist of two pumps having a rated capacity of 4500 gpm at 140 F. The pumps are driven by 75-hp, 1150-rpm, 440-volt, 3-phase, 60-cycle open frame squirrel cage motors.

A two-cell tower serves to cool engine jacket water and a one-cell tower is employed for gas cooling. The spray pumps for these towers are four in number and consist of vertical units each having a capacity of 1900 gpm at 100 F. Driving them are 25-hp, 1150-rpm, 440-volt, 3-phase, 60-cycle motors.

Water supply is from two wells, one 815 ft deep and the other 2460 ft deep. The water requires softening before use.

Buildings other than those mentioned are the pipe line warehouse, which is 61 ft 2 in. by 40 ft; a shop and change room, 61 ft 2 in. by 50 ft 5 in.; the equipment garage, 48 ft 4 in. by 42 ft 7½ in., and the office building, which is 32 ft 2 in. by 26 ft 2 in.



Each station has two cooling towers, for gas and engine jacket water cooling. At Fostoria and Natchitoches both are three-cell units; at Victoria one has two cells, the other one. Water circulating pumps (4500 gpm each) are driven by 75-hp motors.

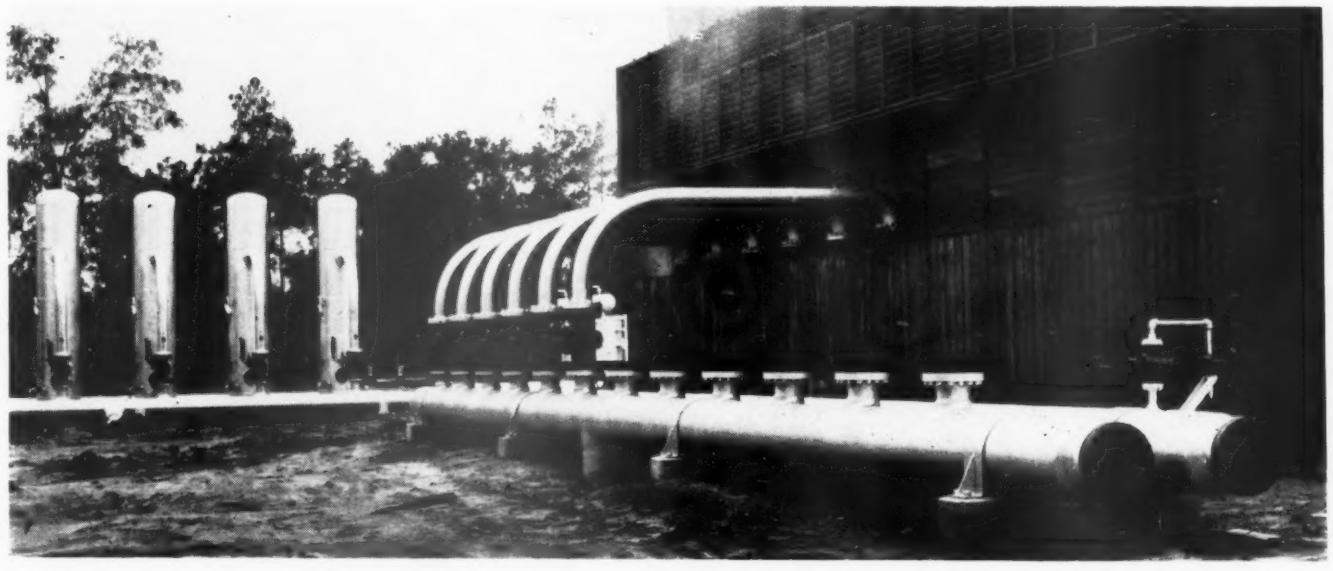
On the station site is a complete camp of eight houses for operating personnel. At Dernal is a spur of the Missouri Pacific Railroad for the unloading of equipment.

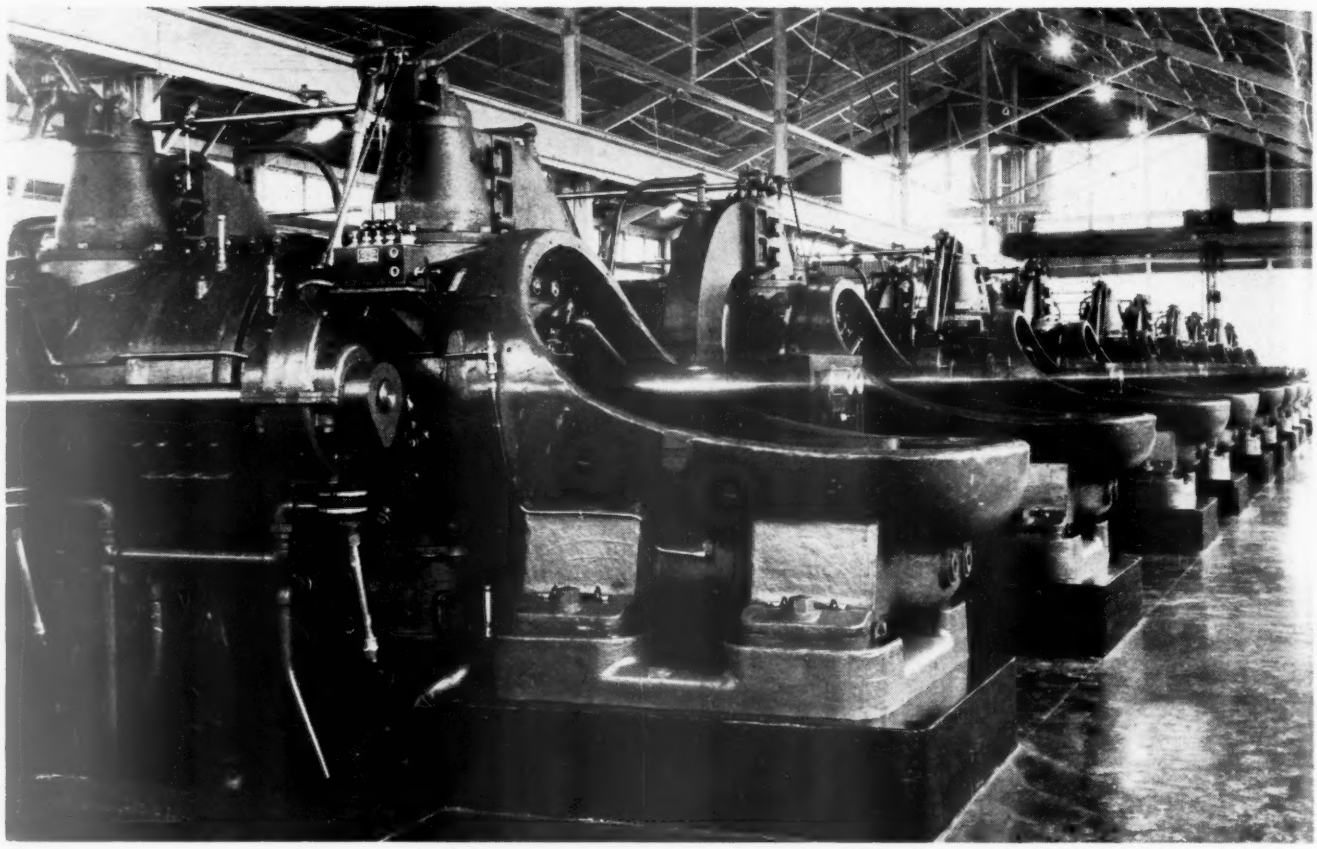
● **Station No. 3—Fostoria, Texas.** The official name of this station is the John P. Bristow station, named for the vice president in charge of operations of Tennessee Gas Transmission Company. Bristow has seen long service in the natural gas transmission industry. Before joining Tennessee he was chief engineer of Northern Natural Gas Company.

The compressor units consist of six 1600-hp horizontal units having 26-in. bore and 36-in. stroke. Three auxiliary generator units consisting of 370-hp 400-rpm gas engines driving 250-kw generators provide electricity. Two cooling towers, one for gas and the other for engine jacket water, are both three-cell installations. Six spray pumps are provided. These are vertical pumps having a capacity of 1900 gpm each at 100 F and are driven by 25-hp, 1150-rpm, 440-volt, 3-phase, 60-cycle motors.

Engine jacket circulating water pumps consist of three centrifugal units having

Suction and discharge header at gas cooling tower. After being compressed the gas is cooled by being passed through coils in the gas-cooling tower. Each station has two gas cooling units in each bay of the tower.





Compressor units installed at Tennessee Gas Transmission Company's three new stations are six each at Fostoria and Natchitoches and three at Victoria. The compressors are 1600-hp horizontal units and are designed ultimately to handle 45,000,000 cu ft daily per engine at a suction pressure of about 490 psi and a discharge pressure of 760 psi. Operation is single stage.

a capacity of 4500 gpm each at 140 F driven by 75-hp, 1150-rpm, 440-volt 3-phase, 60-cycle open frame squirrel cage motors.

At this station there are two water wells, both of which are approximately 1400 ft deep. They produce artesian water that is almost chemically pure and thus requires no treating.

Data on the various buildings are as follows: Main compressor building, 189 ft 10 in. by 75 ft 11 in.; warehouse and loading dock, 24 ft by 80 ft; auxiliary building, 62 ft 4 in. by 51 ft 2¼ in.; pipe line warehouse, 61 ft 2 in. by 40 ft; shop and change room, 61 ft 2 in. by 50 ft 5 in.; equipment garage, 48 ft 4 in. by 42 ft 7½ in.; office building, 32 ft 2 in. by 26 ft 2 in.

The camp for operating personnel at this station consists of 11 houses and there is a railroad spur track at Fostoria, off the Santa Fe Railroad.

● **Station No. 5—Natchitoches, Louisiana.** Officially this station is named the Wyman E. Mueller station. Mueller is vice president in charge of finance and accounting for the company.

This station also has six 1600-hp horizontal compressor units, the bore and stroke of which are the same as for the other two stations. The building housing the compressors is 189 ft 10 in. by 75 ft 11 in. A 62-ft 4-in. by 51-ft 2¼-in. building houses the generating units and the circulating water pumps. There are three 370-hp, 400-rpm gas engines driving 250-kw generators. Also, there are three circulating water pumps, each having a capacity of 4500 gpm at 140 F. The power units are 75-hp, 1150-rpm, 440-volt, 3-phase, 60-cycle open frame squirrel cage motors.

The two cooling towers each have three cells. Spray pumps are six in number and are vertical units having a capacity of 1900 gpm each at 100 F. These are driven by 25-hp, 1150-rpm, 440-volt, 3-phase, 60-cycle motors.

At this station there are five water wells, all of which require pumping. The water sand in one well is from 78 to 95 ft, however the rest are deeper. One well is producing from a sand at 183-200 ft. another at 128-152 ft. one at 133-150 ft. and one at 130-155 ft.

Other buildings at this station are a warehouse and loading dock, which is 24 ft by 80 ft; a pipe line warehouse, 61 ft 2 in. by 40 ft; shop and change room. 61 ft 2 in. by 50 ft 5 in.; equipment garage, 48 ft 4 in. by 42 ft 7½ in., and the office building, which is 32 ft 2 in. by 26 ft 2 in.

This station also has a camp of 11 houses.

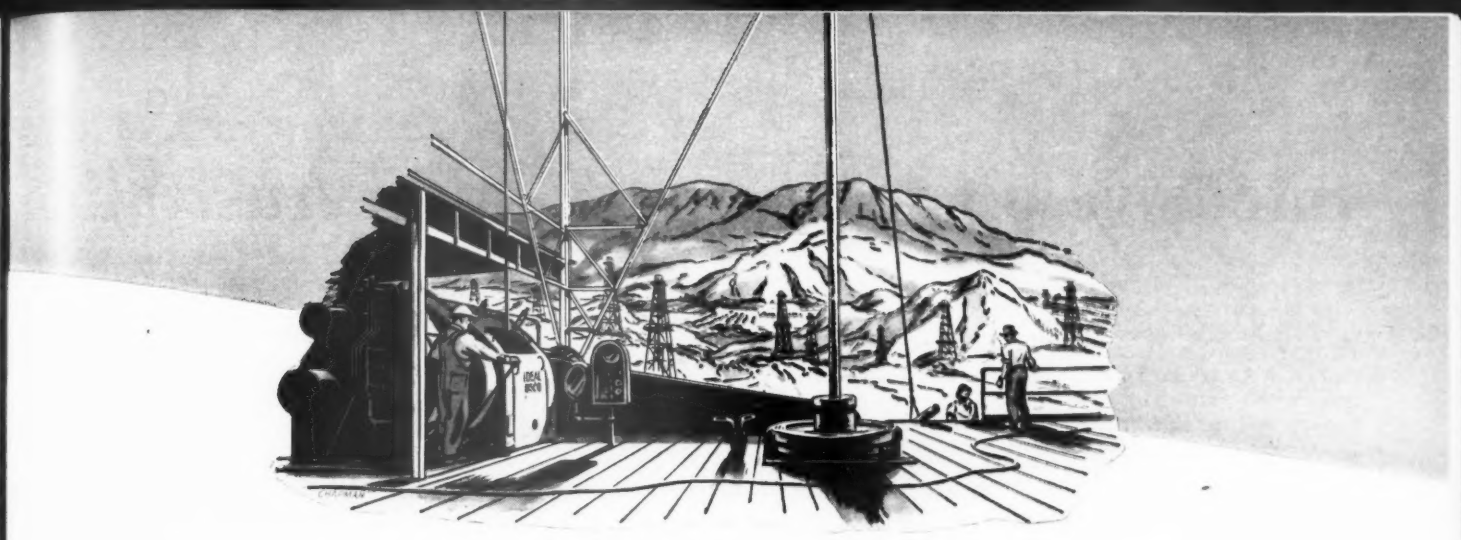
● **Design and construction.** All three stations were designed and constructed by the engineering and construction departments of Tennessee Gas Transmission Company. ★ ★ ★

New company plans Gulf drilling

A new firm is entering the wildcatting in the Gulf of Mexico. The Melben Oil Company, Pittsburgh, Pennsylvania, has been organized for the sole purpose of working on Gulf exploration and drilling. Michael L. Benedum, famous wildcatter, is a member of the firm and his nephew, Paul G. Benedum, is president.

Secret tests in the Gulf have been going on for two years and actual drilling is expected to be in progress in May. The first location is said to be at least three miles offshore between Galveston and Freeport. Drilling will be done from a huge half-million-dollar float, 100 by 120 ft, on which 30 persons can live during operations.

Benedum asked the State of Texas to put up 1,000,000 acres off the coast for competitive bidding, the first indication of the interests of the new company, and 120,480 acres were purchased by Melben Oil at a cost of $1,383,467.



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Intensive oil search goes on in Australia

A VERY extensive oil search is being carried on in Australia. There is determination on the part of the Commonwealth Government to discover what petroleum resources the country has and private companies with world-wide interests are concentrating on the same search.

EXCLUSIVE

W. P. Ashley, Minister for Supply and Shipping of the Commonwealth, has given the following review of the exploration activities in the various provinces and territories:

● **Territory of Papua (New Guinea).** Extensive geological and geophysical surveys are being carried out by Australasian Petroleum Company Proprietary, Ltd. This company's Kariava Bore is drilling at 9136 ft, and two additional rigs are on order.

The survey work has proved that, geologically, a considerable area of New Guinea is an integral part of the so-called "Malaysian" arc, which includes the oil fields of Borneo, Java, and Sumatra, and the newer fields in Dutch New Guinea.

Richfield Oil Corporation geologists have recently examined permit areas held by the Papuan Apinaipi Petroleum Company, Ltd.

● **Queensland.** Shell (Queensland) Development Proprietary, Ltd., has been active on field work in the Mt. Rolleston area and plans to intensify its search when a scout-boring plant arrives from the U. S. A.

A deep-well rig is also on order and will be ready to begin test drilling when structural conditions have been determined.

A group of companies headed by Roma Blocks Oil Company, N. L., is making geological surveys in the Roma district, where high quality oil and wet gas are known to occur in sandstones of Jurassic age, immediately above the granite basement. These companies will be assisted by geophysical parties from the Bureau of Mineral Resources, Geology and Geophysics.

● **Western Australia.** Plans are well advanced to resume drilling on the Nerrima Bore of Freney-Kimberley Oil Company (1932) N. L., where operations were suspended early in the war at 4271 ft in Lower Permian beds. The test is planned to drill through an unknown thickness of Lower Permian rocks, and a few hundred feet into Devonian limestone.

Geologists of Australian Mining and Smelting Company, Ltd., have been making reconnaissance surveys in the North West Cape and Fitzroy River areas. In the first area a large Tertiary basin and in the second area a large Permian basin (and underlying Cretaceous and Permian strata) give some promise of structural conditions favorable to oil accumulation.

● **Northern territory.** The Burt Range Basin on the border of Western Australia is being explored by geologists of Boneparte Gulf Company Proprietary, Ltd.

● **Victoria.** An attempt to obtain oil by drilling radially from a central shaft is being made by the Austral Oil Drilling Syndicate (N. L.) at Lakes Entrance in eastern Gippsland. The oil-bearing formation is a glauconitic sandstone of Oligocene age, which is underlain by granite and schist.

A deep Tertiary basin has been proved in the Nelson-Portland area in western Victoria, where the Nelson Bore suspended drilling at 7305 ft in sediments of Middle Miocene age.

● **New South Wales.** Oil-shale deposits at Newnes are being developed by National Oil Proprietary, Ltd., with financial assistance from the Commonwealth Government.

Modern mining, retorting, and refining practices are employed, but the cost of oil produced here is not competitive with that of the imported product.

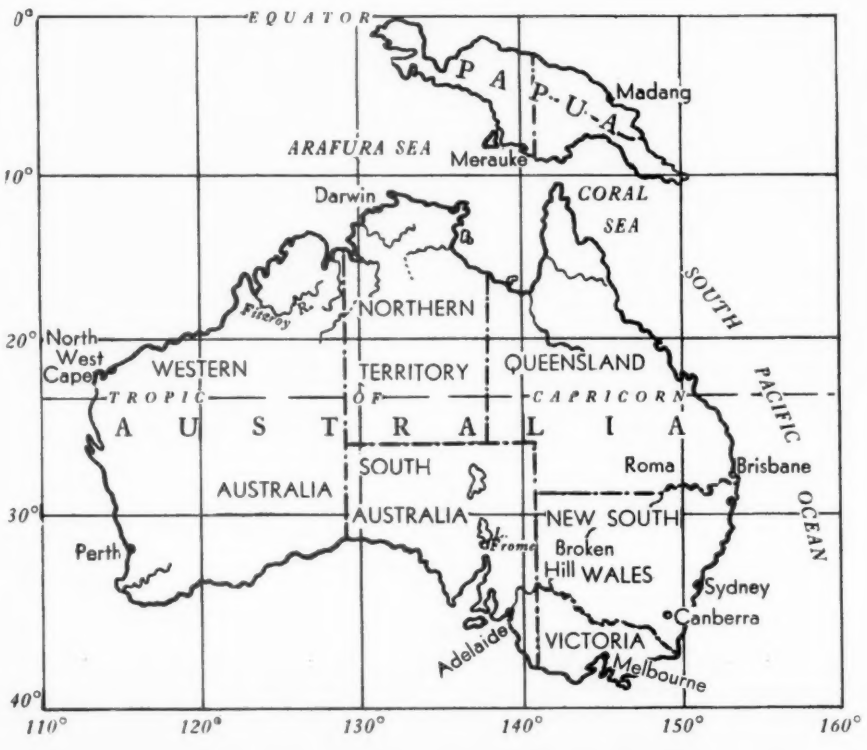
● **South Australia-New South Wales.** In addition to the search for oil in other parts of Australia, an intensive search for natural gas is being conducted by the Frome-Broken Hill Company Proprietary, Ltd., assisted by a geophysical party from the Bureau of Mineral Resources, Geology and Geophysics, in the Lake Frome area, northwest of Broken Hill.

● **General.** The program of petroleum exploration now being carried out in Australia and the Territories is on a far greater scale than any prospecting work attempted in the past.

The larger companies represent American, English, and Australian interests; their field staffs are under the leadership of geologists and geophysicists widely experienced in foreign fields, and their equipment includes the most modern instruments available in the United States.

The work of the private companies is supported by that of the Bureau of Mineral Resources, Geology and Geophysics of the Commonwealth Government Department of Supply and Shipping, which has a wide program of regional mapping and geophysical exploration supported by scout drilling. ★★★

All the provinces and the territory of Papua (New Guinea) are witnessing the operations of exploration parties and drilling crews.



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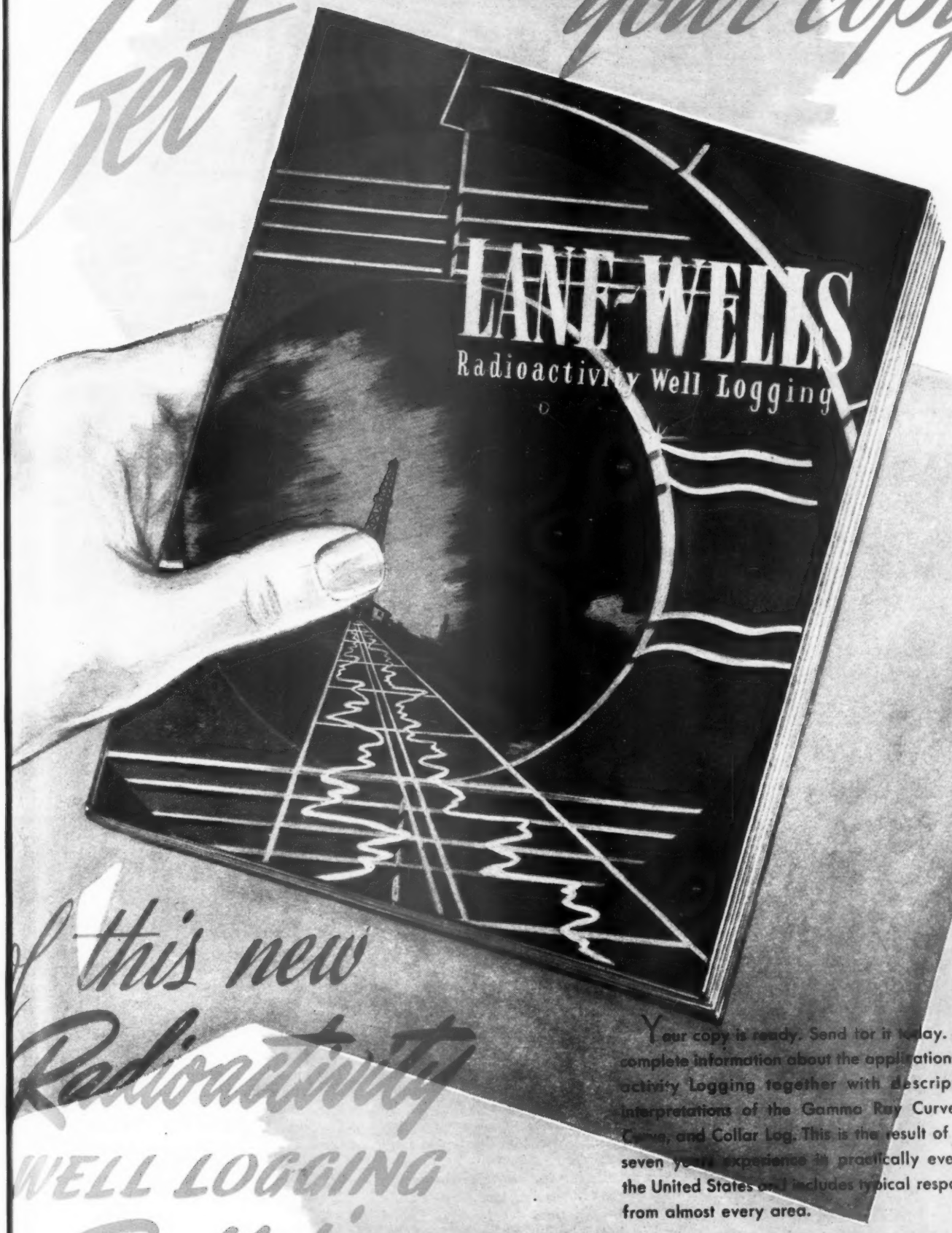

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Hydrocarbon absorption and fractionation process design methods

Part 9. Proposed Absorption-Stripping Calculation Method.

By WAYNE C. EDMISTER,
Hydrocarbon Research, Inc.

EXCLUSIVE

For purposes of this presentation, absorption and stripping are covered to-design calculation methods are identified as *graphical* or *analytical* procedures. It is not possible to make literal classifications of degether as complementary processes and sign methods, however. The graphical method of Sherwood involves some analytical calculations along with the XY diagram construction for the key component. In the so-called analytical methods, the equations are represented on charts, constructed as short-cut aids in solving the equations. The equations, fundamental and short-cut, and charts for the analytical methods were developed in Part 5. The Sherwood graphical method was presented in Parts 6 and 7.

In this, the ninth article of the series and the fifth installment to be devoted to absorption and stripping, a recommended absorption-stripping process design calculation method, using effective factors, is presented by a concise summary, and step-by-step procedures, and illustrated by examples. This method was compared with other methods on the same example in Part 8.

RESUME OF PROPOSED METHOD

Fig. 38 gives a summary of this author's method for making absorption and stripping process calculations. In this one-page resumé, the definitions, equations and charts, as developed in Part 5, are given. The nomenclature indicated on Fig. 27 applies to this summary. Small copies of the three charts presented as Figs. 28, 29, and 30 are included in this resumé for completeness and clarity in outlining and illustrating the various steps of the design procedure.

The absorption and stripping equations given in Fig. 38 have been derived mathematically and are based on two fundamental assumptions; namely: (a) Equilibrium between liquid and gas at each theoretical stage, and (b) effective absorption and stripping factors.

These equations are not limited to the ideal cases of perfectly denuded lean absorption oil or stripping gas but may be used to predict the performance of absorbers and strippers where overlapping occurs—e.g., where the same components appear in both the lean oil and wet gas or in both rich oil and stripping gas. Unless a perfectly denuded and nonvolatile lean oil is used in absorbers. lean oil will be lost into the off gas due to stripping the more volatile components of the lean oil. An analogous situation exists for strippers. Unless a perfectly inert and condensable free stripping gas is used in strippers, there will be absorption of the less volatile components of the stripping gas. Thus absorption and stripping may both occur simultaneously in the same absorber or stripper. Accordingly, both the absorption and the stripping equations must frequently be used in designing an absorber; the former equation being applied to all the components in the wet gas, and the latter to all components in the lean oil, with both absorption and stripping equations being applied to the heaviest gaseous and the lightest liquid components, thus overlapping. The results of these calculations give the direction and quantity of material transfer for each component. Stripping is analogous but usually simpler because the stripping medium, steam, is hydrocarbon free.

For components that appear in both the wet gas and lean oil to an absorber, either absorption or stripping may take place or absorption may prevail on some plates and stripping on others, depending upon the concentrations and operating conditions. It is usually possible to tell at a glance which operation prevails for the various components in this overlapping region. If such is the case, the first term in brackets to the right of the equality sign in either the absorption or stripping equations; i.e.,

$$(1 - L_o X_o / A' V_{n+1} Y_{n+1})$$

or

$(1 - V_o Y_o / S' L_{m+1} X_{m+1})$, may be applied to the components in question. One of these expressions will be negative and one positive for each of the overlapping components. The positive expression indictates the proper equation for that component. This will be illustrated later by an example.

In calculating the effective absorption or stripping factor (A_e and A', or S_e and S') by the equations developed in Part 5 and included in Fig. 38, care should be taken to use the proper values of L, V, and K for computing A or S at the top and bottom plates. The liquid and vapor quantities leaving the plate (top or bottom) and K at the condition of the plate in question should be used. These liquid and vapor quantities, which are not known accurately until the solution is complete, may be estimated by assuming the total absorption and prorating this to obtain the quantities absorbed on the top and bottom plates. This proration step was illustrated in the last installment and will be illustrated further in an example later.

Two features recommend the Edmister method for process design of absorbers and strippers; namely: (1) The use of effective absorption (or stripping) factors that are simple functions of the terminal (top and bottom plates) conditions and independent of the number of plates, and (2) a convenient way of allowing for the presence of solute components in the solvent and for the loss of lean oil into the residue gas.

This method will be illustrated further by two other examples, one being to find the lean oil required to get a desired recovery of the key component and the other being a comprehensive absorber design problem where lean oil components are stripped into the residue gas.

Example 22. A further illustration of this proposed method follows in the computation of the amount of lean oil required to recover 56.8 per cent of the butane in the following wet gas, which is to be processed in an absorber containing four theoretical plates. It will be assumed that the lean oil is perfectly denuded. This is an example used by Horton-Franklin. The solution by Horton-Franklin's method will be included for comparison with the solution by the Edmister method.

Component	Mols
Methane	0.253
Ethane	0.179
Propane	0.223
n-Butane	0.240
n-Pentane	0.105
	1.000

The absorber is to operate at a pressure of 4 atmospheres absolute. The lean oil is assumed to be at a temperature of 90 F. Thus, the K constants will be the same as for the previous examples.

The required effective absorption factor for butane is calculated as follows:

$$\frac{Y_{n+1} - Y_1}{Y_{n+1} - Y_o} = 0.568 = \frac{A_e^5 - A_e}{A_e^5 - 1}$$

From Fig. 28 (Part 5) the value of A_e for n-butane is found to be 0.603.

Soluton via Horton-Franklin Method. From tabulation the location of the effectve absorption factor is found as follows:

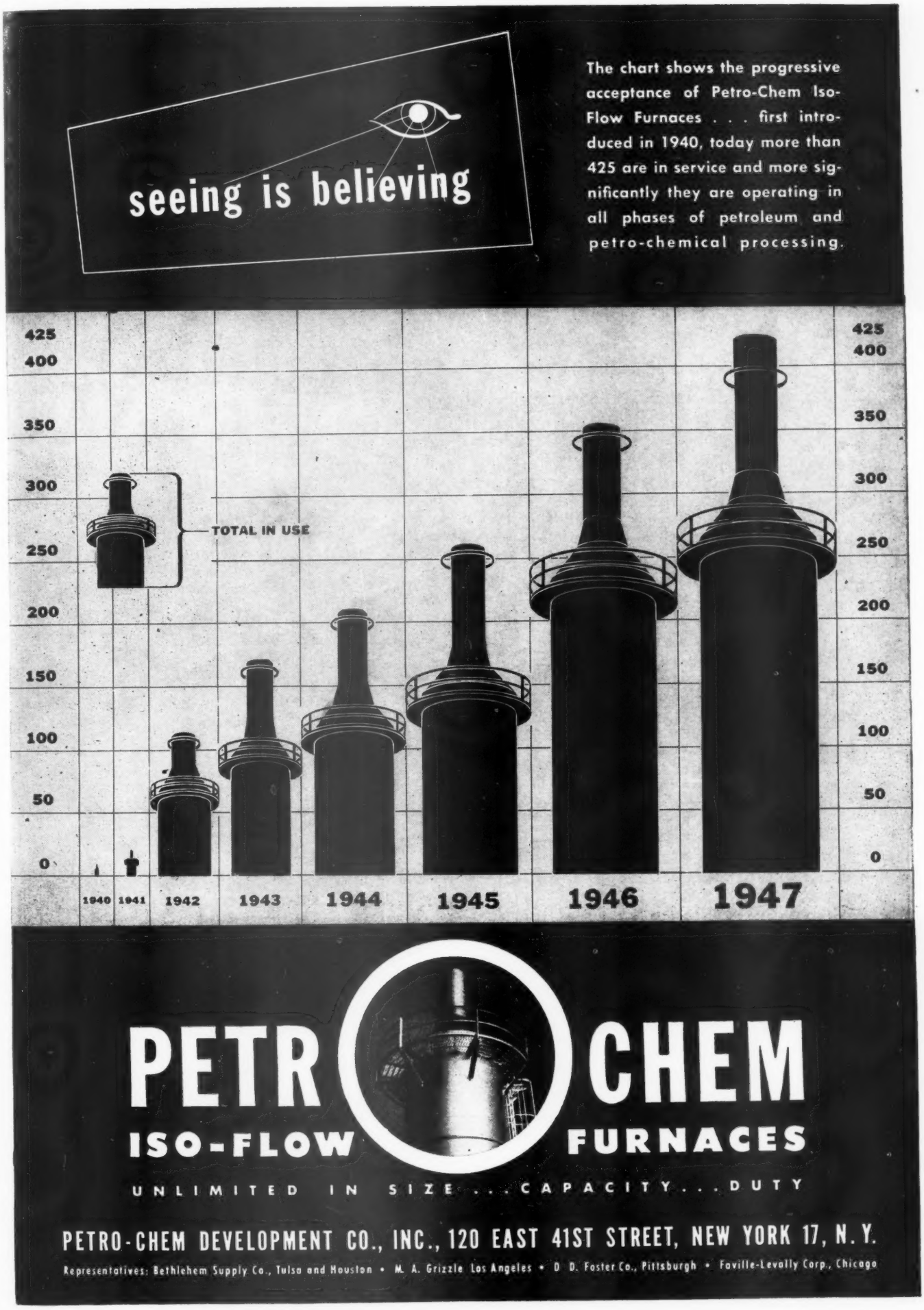
seeing is believing
The chart shows the progressive acceptance of Petro-Chem Iso-Flow Furnaces . . . first introduced in 1940, today more than 425 are in service and more significantly they are operating in all phases of petroleum and petro-chemical processing.
425
400
350
300
250
200
150
100
50
0
TOTAL IN USE
1940
1941
1942
1943
1944
1945
1946
1947
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FIG. 38.

SUMMARY OF EDMISTER ABSORPTION AND STRIPPING CALCULATION METHOD

This method employs effective A and S factors, which are algebraic and graphical functions of terminal conditions, with absorption and stripping efficiency equations that allow for presence of solute in lean oil. Equations are based on theoretical equilibrium plate concept and following definitions of terms:

X = mols of any component in the liquid phase per mol of liquid entering absorber or stripper.

Y = mols of any component in the vapor phase per mol of vapor entering absorber or stripper.

K = phase equilibria constant = y/x = ratio of mol fraction in vapor to mol fraction in liquid.

L = mols of liquid.

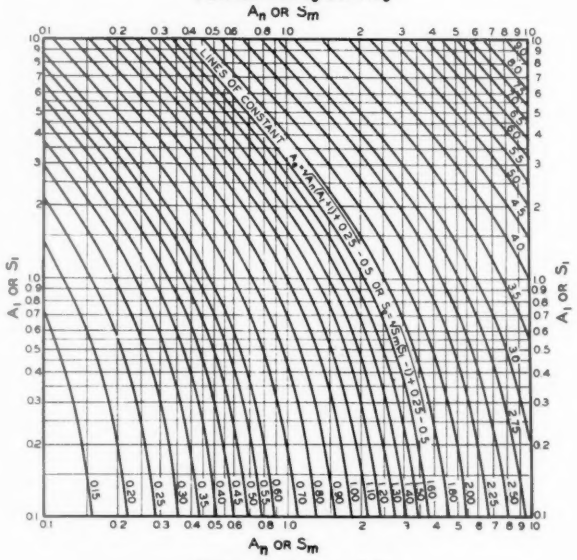
V = mols of vapor.

E_a = absorption efficiency.

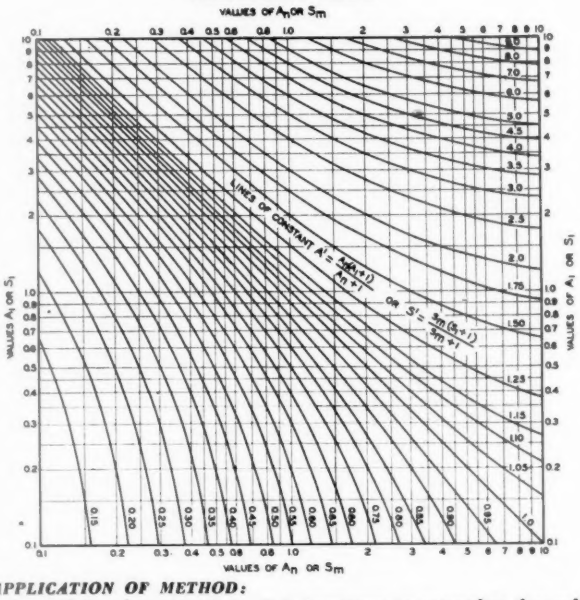
E_s = stripping efficiency.

Subscripts denote theoretical plate; numbered from top to bottom for absorbers, and from bottom to top for strippers.

Values of A_e and S_e



Values of A′ and S′



APPLICATION OF METHOD:

In applying these equations, it is important to remember that subscript 1 and n apply to terminal plates. Thus L_1, used in calculating A_1 is the liquid leaving the top plate and not the lean oil entering the absorber.

It is sometimes necessary to apply both absorption and stripping equations to same problem. Some components may be stripped from the lean oil in an absorber.

More than one trial may be necessary to get terminal conditions correctly adjusted.

ABSORPTION

Absorption factor, A = L/VK.

Algebraic plate-to-plate solution of absorber of n plates.

$$E_a = \frac{Y_{n+1} - Y_1}{Y_{n+1}} =$$

$$\left(\frac{A_1A_2A_3 \dots A_n + A_2A_3 \dots A_n + \dots + A_n}{A_1A_2A_3 \dots A_n + A_2A_3 \dots A_n + \dots + A_n + 1}\right) -$$

$$\frac{L_oX_o}{V_{n+1}Y_{n+1}}\left(\frac{A_2A_3 \dots A_n + A_3 \dots A_n + \dots + A_n + 1}{A_1A_2A_3 \dots A_n + A_2A_3 \dots A_n + \dots + A_n + 1}\right)$$

Simplification by use of effective absorption factors

$$E_a = \frac{Y_{n+1} - Y_1}{Y_{n+1}} = \left[1 - \frac{L_oX_o}{A'V_{n+1}Y_{n+1}}\right]\left[\frac{A_e^{n+1} - A_e}{A_e^{n+1} - 1}\right]$$

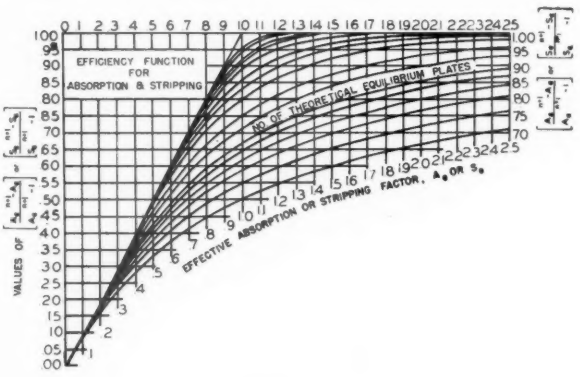
Where A′ and A_e are defined by the corresponding terms in the above two equations.

Mathematical derivations give A′ and A_e as functions of terminal conditions only

$$A_e = \sqrt{A_n(A_1 + 1) + 0.25} - 0.5$$

$$A' = \frac{A_n(A_1 + 1)}{A_n + 1}$$

These A_e and A′ functions are represented graphically as is the last term of the absorption efficiency equation.


EFFICIENCY FUNCTION FOR ABSORPTION & STRIPPING
NO. OF THEORETICAL EQUILIBRIUM PLATES
EFFECTIVE ABSORPTION OR STRIPPING FACTOR, Ae OR Se

STRIPPING

Stripping factor, S = VK/L.

Algebraic plate-to-plate solution of stripper of m plates.

$$E_s = \frac{X_{m+1} - X_1}{X_{m+1}} =$$

$$\left(\frac{S_1S_2S_3 \dots S_m + S_2S_3 \dots S_m + \dots + S_m}{S_1S_2S_3 \dots S_n + S_2S_3 \dots S_n + \dots + S_n + 1}\right) -$$

$$\frac{V_oY_o}{L_{m+1}X_{m+1}}\left(\frac{S_2S_3 \dots S_m + S_3 \dots S_m + \dots + S_m + 1}{S_1S_2S_3 \dots S_m + S_2S_3 \dots S_m + \dots + S_m + 1}\right)$$

Simplification by use of effective stripping factors.

$$E_s = \frac{X_{m+1} - X_1}{X_{m+1}} = \left[1 - \frac{V_oY_o}{S'L_{m+1}X_{m+1}}\right]\left[\frac{S_e^{m+1} - S_e}{S_e^{m+1} - 1}\right]$$

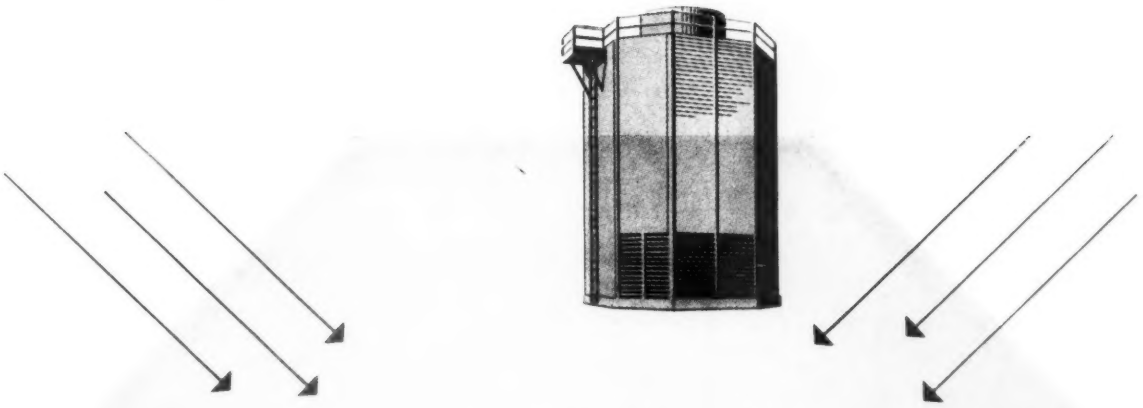
Where S_e and S′ are defined by the corresponding terms in the above two equations.

Mathematical derivations give S′ and S_e as functions of terminal conditions only.

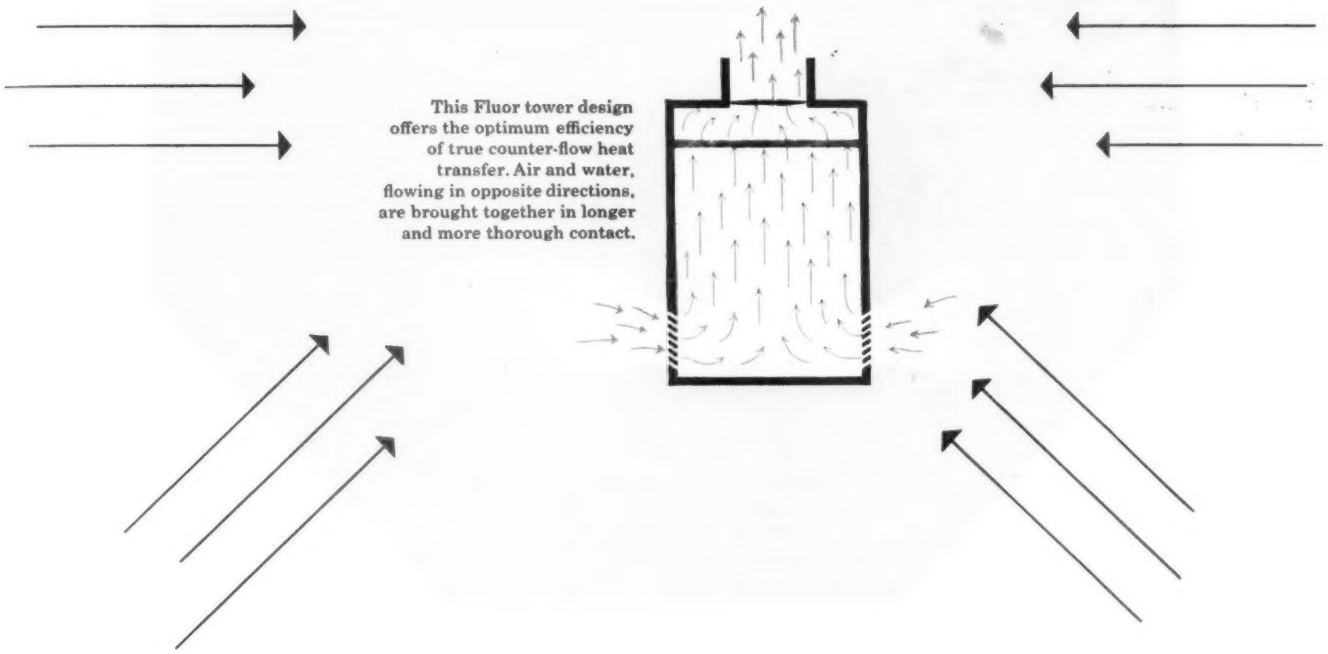
$$S_e = \sqrt{S_m(S_1 + 1) + 0.25} - 0.5$$

$$S' = \frac{S_m(S_1 + 1)}{S_m + 1}$$

These S_e and S′ functions are represented graphically as is the last term of simplified stripping efficiency equation.



EFFICIENT TOWER DESIGN = Colder Water Cheaper

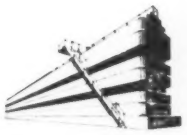


This Fluor tower design offers the optimum efficiency of true counter-flow heat transfer. Air and water, flowing in opposite directions, are brought together in longer and more thorough contact.

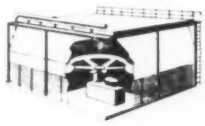
Cheaper? Yes, and here's why: Exhaustive field tests reveal the presence of "dead corner areas" in the conventional induced draft cooling tower, which seriously impair performance.

The new octagonal design of the Fluor "Counterflo" Tower not only eliminates stagnant corner areas, but provides a greatly increased intake area from six sides, thus assuring more uniform air distribution within the tower.

Add to this efficient tower design such other Fluor firsts as the patented upspray "Spirodome" water distributing system, proper design and arrangement of grid decking to assure longer air-water contact, fan and gearing developed to give long service life, and rigid time-resistant construction throughout—and you'll find that they all add up to lower operational costs—which means colder water cheaper!



Fluor areator atmospheric cooling towers are recommended where conditions make this type most practical.



The Fluor Fin-Fan cooling unit has a wide range of utility throughout industry.

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$i/n = 0.80$

$i = 3.2$ = location of effective plate for key component, n-butane.

Assume:

(a) The overall knockout is 0.285, and the temperature rise is 30 F. This gives

$V_1 = 1.0 - 0.285 = 0.715$

(b) $V_i = V_1^{\left(\frac{n+1-i}{n}\right)}$

(c) $120 - T_i = 30\left(\frac{1.0 - V_{i+1}}{0.285}\right)$

At plate "3.2"

$V_1 = V_{3.2} = 0.715^{\frac{1.8}{4}} = 0.86$

$V_{i+1} = V_{4.2} = 0.715^{\frac{0.8}{4}} = 0.936$

$T_1 = T_{3.2} = 120 - 30\left(\frac{1.0 - 0.936}{0.285}\right)$

$= 113$ F.

Knowing the required A_e for n-butane from above calculation, the values of L_1 and Lo will be estimated. $A_e = 0.603$

$A_e = 0.603 = A_{3.2}$

$K_{3.2} = 1.05$ for n-butane

$L_1 = L_{3.2} = A_{3.2} \times V_{3.2} \times K_{3.2} =$
$0.603 \times 0.86 \times 1.05 = 0.545$

By a material balance:

$L_o = L_1 + V_1 - V_{1+1}$

$L_o = 0.545 + 0.715 - 0.936 = 0.324$

Mols of lean oil required per mol of wet gas is 0.324 as compared to the value of 0.356 found by Horton and Franklin via plate-to-plate calculations.

The next step in the solution of this example would be to compute the total absorption to check the assumed knockout of 0.285 mols. This will not be necessary in this particular case, however, because Horton and Franklin did so by plate-to-plate calculations and also the following calculations by the Edmister method constitutes a check.

Solution via Edmister Method. In solving this type of problem by the Edmister method, the lean oil rate is found by trial with adjustments in the total knockout as required. The correct solution is the one that gives the desired recovery of the key component, n-butane.

This illustration is simplified by starting with the results of the Horton-Franklin solution as a basis for the calculation. To recapitulate the assumed starting data for these calculations are:

Total absorption = 0.285 mols

Temperature rise of oil = 30 F.

Lean oil = 0.324 mols

Note that the lean oil quantity is that obtained by the above Horton-Franklin solution of the problem and slightly lower than reported by Horton and Franklin as the results of their plate-to-plate calculations. The temperature rise is found from a heat balance.

First find the values of L, V, and T for the top and bottom plates. By the vapor shrinkage approximation equation the change in vapor quantity across each plate is:

TABLE 40.—Absorption computations for Example 22.

Component	Wet gas mols	K constants 97 F	K constants 120 F	Absorption factors A_1	Absorption factors A_n	Absorption factors A_e	Fraction absorbed	Mols absorbed
Methane	0.253	51.0	56.0	0.0106	0.0118	0.0118	0.0118	0.0029
Ethane	0.179	13.0	15.5	0.0416	0.0426	0.0424	0.0424	0.0076
Propane	0.223	3.1	4.0	0.1743	0.1654	0.1665	0.166	0.0370
n-Butane	0.240	0.85	0.14	0.636	0.580	0.600	0.565	0.1355
n-Pentane	0.105	0.255	0.275	2.12	1.763	1.900	0.965	0.1013
	1.000							0.2843

$\left(\frac{V_1}{V_{n+1}}\right)^{1/4} = (0.715)^{0.25} = 0.92$

$V_1 = 0.715$ mols

$V_4 = 0.92$ mols

$L_1 = L_0 + V_2 - V_1$

$L_0 = 0.324$

$V_2 = \frac{0.715}{0.92}$

$V_1 = 0.715$

$L_1 = 0.324 + \left(\frac{0.715}{0.92}\right) - 0.715 = 0.387$

$L_4 = 0.324 + 0.285 = 0.609$

The L/V ratios are:

$\left(\frac{L_1}{V_1}\right) = \frac{0.387}{0.715} = 0.540$

$\left(\frac{L_n}{V_n}\right) = \frac{0.609}{0.92} = 0.661$

The terminal plate temperatures are:

$T_4 = 90 + 30 = 120$ F.

$T_1 = 120 - 30\left(\frac{1.0 - \frac{0.715}{0.92}}{0.285}\right) = 97$ F.

Using the above conditions and K constants consistent with those used in Examples 18, 19, 20, and 21 (i.e. from the same source) the calculations given in Table 40 complete the solution for this problem.

It will be noted that the recovery of n-butane is found to be 56.5 per cent as compared with 56.8 per cent desired and that the total absorption is 0.2843 mols as compared with the asumption of 0.285 mols. This checks the previous solution and 0.324 mols of lean oil. The other assumption made for the solution of this problem, i.e. 30 F temperature rise, can be checked by a heat balance at this point.

From the above it appears that the Horton-Franklin method is more convenient than the Edmister method for estimating the required lean oil rate for a given key component recovery. If, in both solutions, the total recovery had been computed to check the assumed, there would not have been much difference.

This last example was an absorption design problem of the kind identified as Type II in a previous chapter (Part 7). Examples 18, 19, 20, and 21 (of Part 8) are the kind of design problems identified as Type I in (Part 7).

In these Type I and II problems the number of theoretical plates have been fixed and either the recovery for a given oil rate or the oil rate for a given recovery have been the objective of the calculations.

If the number of plates is not fixed but is an objective of the design calculations, two other types of problems are possible, one to find the recovery with given oil rate and the other to find the oil rate for a given recovery.

In the case where the lean oil quantity is fixed and the variable is absorber height, an additional assumption must be made regarding the number of theoretical plates required for a given recovery of the key component. This does not greatly complicate the calculation, however, because the effect of adding or subtracting plates may be estimated from any completed solution. Using the effective absorption factors obtained from the first trial, the required number of plates for the second trial can be determined from equation (47) or Fig. 28.

ESTIMATION OF TOP AND BOTTOM PLATE TEMPERATURES

In the previous examples the temperatures on the terminal (top and bottom) plates were estimated for adiabatic operation, making a heat balance to get the rich oil temperature and then finding the top plate temperature from equation (50), which assumes that the temperature change in an absorber is proportional to the gas contraction. The residue off gas temperature (same as top plate) is required in making the heat balance. Thus, this method of finding temperatures involves trial and error calculations, which depend upon the amount of absorption and the assumption of adiabatic operation as well as the temperatures of the wet gas and lean oil.

In estimating temperatures in this way, no phase equilibrium computations are involved. Bubble and dew point calculations would be meaningless unless heat is removed from the absorber in such quantities and at such locations so as to keep the top temperature at the off gas dew point and the bottom temperature at the rich oil bubble point. Theoretically, this heat removal should take place on each plate but this is not practical so one or more intercoolers are frequently used in commercial installations to remove heat from the solvent as it flows down the absorber.

Without this cooling, the temperatures would be above the phase equilibrium temperatures, but absorption takes place just the same at a slower rate. The gas need not be at its dew point for components of it to diffuse into the lean oil. It is not necessary to remove enough

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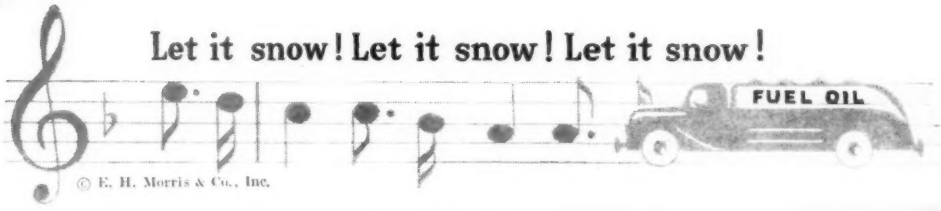

With TCC, you can vary your product distribution at will, according to seasonal demand. You can get optimum yields of motor gasoline in the summer, when it's hot. And in the winter, when it's not, you can get proportioned production of distillate heating oil.

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TABLE 41.—Preliminary absorption calculations for Example 23.

	Feed, mols per hr — Wet gas $Y_{n+1}V_{n+1}$	Lean oil L_oX_o	$K_{65\ psia}^{90\ F}$	A=L/KV	S=KV/L	$\frac{An+1-A}{An+1-1}$	$\frac{Sn+1-S}{Sn+1-1}$	$1-\frac{L_oX_o}{AV_{n+1}Y_{n+1}}$	$1-\frac{V_{n+1}Y_{n+1}}{SL_oX_o}$	E_a	F_s	Absorption from wet gas, mols/hr	Striping from lean oil, mols/hr
C_1	10		41.0	0.0244		0.0244		1.0		0.0244		0.244	
C_2	30		7.3	0.137		0.137		1.0		0.137		4.12	
C_3	40		2.3	0.435		0.435		1.0		0.435		17.70	
C_4	30	10	0.74	1.35	0.74	0.90	0.665	0.753	3.0	0.678		20.25	
C_5	10	50	0.22	4.55	0.22	1.00	0.22	0.10	0.09	..	0.0198	..	0.99
C_6	..	15	0.074	13.5	0.074	1.00	0.074	..	1.0	..	0.074	..	1.11
C_7	..	5	0.027	37.0	0.027	1.00	0.027	..	1.0	..	0.027	..	0.13
	120	80										42.314	2.23

heat to maintain equilibrium conditions but it is of interest to know how much heat should be removed to reach equilibrium and what temperatures would prevail.

This can be done by another temperature estimating method, which will be described below and then illustrated by the next example. Three separate but related calculation steps are involved:

(a) Estimate temperature of top plate and check by heat balance around this plate;

(b) Estimate temperature of bottom plate and check by heat balance around this plate, and

(c) Using these temperatures, make overall heat balance on absorber and find the amount of heat that must be removed by cooling to maintain these temperatures. These three steps are obviously based on estimated absorption recoveries for all components and must be preceded by a preliminary component material balance.

Estimating and checking the top and bottom plate temperatures are similar procedures, differing only in that dew point is the key to the top plate and bubble point is the key to the bottom plate calculation. In making these equilibrium calculations it is necessary to have a component breakdown for the lean oil and treat the solvent as a complex mixture rather than one inert fraction. The top plate temperature is found and checked as follows:

Step 1. Assume a likely top plate temperature and find the composition of the liquid in equilibrium with the off gas. This calculation will not include all the lean oil components unless these components also appear in the residue gas, which they will only if solvent stripping estimates have been made and even then the quantities might be questionable. If the residue gas composition used in this dew point calculation does not contain the lean oil components, there will be a "void" in the top tray liquid composition. For these reasons these results must be combined with a component material balance to account for the lean oil components properly.

Step 2. Estimate the quantity and composition of the liquid leaving the top tray by using the partially complete liquid composition from the equilibrium calculations of Step 1 and assuming that the "void" will be filled by the amounts of the lean oil components. In other words, all heavier lean oil components are assumed to go right on through the top plate and appear in the top tray liquid. This top tray liquid quantity may be checked by the method used in Examples 18 and 19 for estimating it. It will be recalled that the total absorption was prorated to find the quantity transferred from the gas to the liquid on the top plate.

Step 3. Estimate the temperature of the vapor leaving the top plate. This requires a knowledge of the temperature gradient in the absorber, which follows an assumption or estimation of the bottom plate temperature.

Step 4. Make heat balances to check the assumed calculated temperatures. Adjustments and changes may be found necessary.

The same procedure is repeated for the bottom plate to find and check the temperature at this point. After both top and bottom plate temperatures are found an overall heat balance can be made to find the intercooling duty.

Absorber heat balances are at best uncertain calculations because of the inadequacy of the enthalpy data, particularly heats of absorption. The lighter hydrocarbons are absorbed at temperatures above their critical so latent heats of vaporization cannot be used. As a substitute for the heats of absorption, it is usually possible to estimate the enthalpies of the mixed vapor and liquid streams and make *fraction* rather than *component* heat balances.

COMPREHENSIVE ILLUSTRATION

In Part 7, Type III absorption design procedure and examples covered finding the lean oil rate and number of plates for a desired recovery. This is the usual design problem but, as pointed out above, the number of plates variable can best be handled in this method by making a solution for an assumed number of stages and then adjusting and/or repeating the calculations for an increased or decreased number of stages. In this respect the graphical procedure of Sherwood is useful. An example illustrating these calculations is not necessary; however, it is of interest to include an example wherein lean oil stripping and intercooling are features of the ab-absorption operation.

In developing and describing the proposed method, it was shown that the equations and procedure were versatile enough to include the lean oil stripping as well as the presence in the lean oil of some of the solute components. The following example will be more comprehensive than the previous ones and will illustrate the simultaneous application of the stripping and absorption equations to the components appearing in both the wet gas and lean oil as well as the application of the stripping equation to the lean oil components not appearing in the wet gas. It will also illustrate the non-adiabatic absorber design procedure described above, showing the equilibrium method of finding top and bottom plate temperature.

Example 23. A problem wherein some of the components in the lean oil are stripped out and lost in the off gas and intercoolers are employed is solved in this illustration of the Edmister method. The following wet gas and lean oil streams are charged to a four plate absorber that operates at 50 psig. Oil and gas enter at 90 F. Compute the off gas and the rich oil.

	Wet gas, mols/hr	Lean oil, mols/hr
C_1	10	
C_2	30	
C_3	40	
C_4	30	10
C_5	10	50
C_6		15
C_7		5
Total	120	80

Step 1. Approximate the quantities of each component absorbed in order to prepare the way for more precise absorption calculations. As a first approximation assume that 40 mols are absorbed. making the off gas $120 - 40 = 80$ mols and the rich oil $80 + 40 = 120$. The average:

$$\frac{L}{V} = \frac{80 + \frac{40}{2}}{120 - \frac{40}{2}} = 1.0$$

Assume for the time being that the operation is isothermal at 90 F. These assumptions are only used in preparing the way for more precise calculations. The mols absorbed are estimated as shown in Table 41 from these assumptions.

This total absorption (42.314—2.23= 40.084) checks the assumed closely enough to justify proceeding further. The negative signs in the

$(1-L_oX_o/AV_{n+1}Y_{n+1})$ and

$(1-V_{n+1}Y_{n+1}/SL_oX_o)$ column indicate that the other (i.e. stripping or absorption) operation prevails for the component in question. In these preliminary calculations the average A was used for both A_e and A′, and likewse for S. Later solutions of the equations will use the proper effective factors.

Table 42 gives a component material

balance prepared from the results of the above calculations.

Step 2. Find the temperature of the top plate and the composition of the liquid leaving the top plate by a dew point calculation on the off gas. This calculation is simplified in this problem by the fact that the off gas contains all components in the lean oil. In this case the top temperature may be found by dew point calculation only, there being no "void" in the liquid to fill with heavier components. If the wet gas had contained some of the C_6 and C_7 components, the determination of the top temperature would involve an extra step (i.e. a heat balance). In that case the procedure would be: (a) assume a temperature, (b) make a dew point calculation, (c) fill the "void," (d) compute the top tray liquid, (e) make a heat balance to check assumed top tray temperature, (f) repeat calculations (a) to (e) if check is not obtained.

Assume a top tray temperature of 102 F and find dew point of residue gas. This calculation is given in Table 43. The amount of the C_7 component in the top tray liquid may be assumed to be equal to the amount in the lean oil since most of the stripping of the small amount (0.13 mols stripped) will be distributed down the column. Two conditions must be satisfied, i.e. the composition of the top tray liquid and the amount of C_7 in this top tray liquid. As the amount of C_7 in the $V_{n+1}Y_1/K$ term is lower than the amount of C_7 in the lean oil, the entire quantity must be prorated upward giving 98 mols of liquid. The average molecular weight of the top tray liquid is $\frac{6827}{98} = 68.5$. The difference (79.454 vs. 79.93) indicates that the assumed temperature of 102°F is only slightly too high. It is convenient, and sufficiently accurate, to make this proration and go ahead with calculations.

Next a material balance will be made around the top plate to give the vapor rising from the second plate. This is given in Table 44.

Step 3. The temperature of the bottom plate and rich oil leaving the tower, and the composition of the bottom plate vapor will be found by a bubble point calculation on the rich oil. This calculation is given in Table 45 for the final assumption, which was 94 F.

The bubble point temperature of the rich oil is found to be 94 F in Table 45. The last column gives the composition of the bottom tray vapor after prorating to give the correct total amount of C_1, which is 10 mols. The amount of this component in the bottom plate vapor may be assumed equal to the quantity of that component in the entering wet gas because the small amount of this component absorbed will be distributed up the column, making the amount absorbed on the bottom plate very small. By coincidence the magnitude of the adjustment necessary here is less than in the top plate calculation.

Step 4. Next make an overall balance on the absorber to check these temperatures. Two types of heat balances may be made: (1) Component heat balances, in which enthalpies for each component are determined, and (2) average fraction heat balance, in which the enthalpies are found for each stream by using the average molecular weight of the stream. The former is more accurate but requires data not readily available. The latter is shorter so for this heat balance the average fraction method will be used. Table 46 gives the heat balance.

The above heat balance shows that 250,000 Btu per hr of heat must be removed in order to even come close to accomplishing the assumed absorption setup in Step 1. This may be done by means of an intercooler on the oil. If less heat

TABLE 42.—Preliminary balance for Example 23.

		Material in per hr				Material out per hr			
		Wetgas		Leanoil		Offgas		Rich oil	
Component	Mol. wt	Mols	Lb	Mols	Lb	Mols	Lb	Mols	Lb
C_1	16	10	160			9.75	156	0.25	4
C_2	30	30	900			25.90	777	4.10	123
C_3	44	40	1760			22.30	980	17.70	780
C_4	58	30	1740	10	580	9.75	570	30.25	1750
C_5	72	10	720	50	3600	10.99	790	49.01	3530
C_6	86			15	1290	1.11	96	13.89	1194
C_7	100			5	500	0.13	13	4.87	487
Total		120	5280	80	5970	79.93	3382	120.07	7868
Avg mol wt		44		75		41		66	

TABLE 43.—Residue gas dew point calculation for Example 23.

	Mols off gas $V_{n+1}Y_1$	$K_{65\ psia}^{102\ F}$	$V_{n+1}Y_1$ / K	Top tray liquid		
				Mol fraction	Mols	Lb
C_1	9.75	43.6	0.224	0.0028	0.27	4
C_2	25.90	8.0	3.240	0.0407	3.99	120
C_3	22.30	2.6	8.580	0.1080	10.59	465
C_4	9.75	0.88	11.10	0.1395	13.65	791
C_5	10.99	0.27	40.65	0.5120	50.20	3618
C_6	1.11	0.096	11.60	0.1460	14.30	1230
C_7	0.13	0.032	4.06	0.0510	5.00	500
	79.93		79.454	1.00	98.00	6728

TABLE 44.—Component material balance around top tray (or Example 23).

		Material out per hr				Material in per hr			
		Off gas		Top tray liquid		Lean oil		2nd tray vapor*	
Component	Mol wt	Mols	Lb	Mols	Lb	Mols	Lb	Mols	Lb
C_1	16	9.75	156	0.27	4			10.02	160
C_2	30	25.90	777	3.99	120			29.79	884
C_3	44	22.30	980	10.59	465			32.61	1434
C_4	58	9.75	570	13.65	791	10	580	13.40	781
C_5	72	10.99	790	50.20	3618	50	3600	11.19	800
C_6	86	1.11	96	14.30	1230	15	1290	.41	36
C_7	100	0.13	13	5.00	500	5	500	.13	13
Total		79.93	3382	98.00	6728	80	5970	97.93	4140
Avg mol wt		41		68.5		75		42.3	

*By material balance.

TABLE 45.—Rich oil bubble point calculation for Example 23.

	Mols rich oil L_0X_n	Assume 94 F		Bottom plate vapor		
		$K_{65\ psia}^{94\ F}$	$(L_0X_n)K$	Mol fraction	Mols	Lb
C_1	0.25	42.0	10.50	0.088	10	160
C_2	4.10	7.4	30.35	0.254	28.9	867
C_3	17.70	2.4	42.50	0.356	40.5	1780
C_4	30.25	0.79	23.30	0.195	22.2	1290
C_5	49.01	0.235	11.52	0.096	10.9	785
C_6	13.89	0.082	1.14	0.010	1.1	95
C_7	4.87	0.0265	0.13	0.001	0.1	10
	120.07		119.44	1.000	113.7	4987

TABLE 46.—Heat balance for Example 23.

Heat in	Lb/hr	Temperature, F	Condition	Btu/lb	Btu/hr
Wet gas	5,280	90	65 psia vapor	184	972,000
Lean oil	5,970	90	Liquid	33	197,000
Total	11,250				1,169,000
Heat out					
Off gas	3,382	102	65 psia vapor	190	643,000
Rich oil	8,868	94	Liquid	35	276,000
Total	11,250				919,000
Intercooler duty by difference					250,000

TABLE 47.—Terminal A and S factors for Example 23.

	Top plate			Bottom plate		
	$K^{102\ F}_{65\ psia}$	$A_1=\frac{L}{KV}$	$S_m=\frac{KV}{L}$	$K^{94\ F}_{64\ psia}$	$A_n=\frac{L}{KV}$	$S_1=\frac{KV}{L}$
C_1	43.6	0.0282		42.0	0.0251	
C_2	8.0	0.154		7.4	0.1426	
C_3	2.6	0.473		2.4	0.439	
C_4	0.88	1.398	0.716	0.79	1.335	0.75
C_5	0.27	4.550	0.2195	0.235	4.49	0.2225
C_6	0.097		0.0789	0.082		0.0777
C_7	0.032		0.0260	0.0265		0.0251

TABLE 48.—Effective absorption and stripping factors for Example 23.

	A_1	A_n	A_e	A'	S_1	S_m	S_e	S'
C_1	0.0282	0.0251	0.0251					
C_2	0.154	0.1426	0.144					
C_3	0.473	0.439	0.4475					
C_4	0.398	0.335	0.358	0.370	0.716	0.75	0.74	0.736
C_5	4.550	4.49	4.51	4.535	0.2195	0.2225	0.222	0.221
C_6					0.0789	0.0777	0.078	
C_7					0.0251	0.0260	0.026	

is removed the temperatures will be higher and less will be absorbed by the lean oil. If the cooling is low enough the temperatures may not be bubble and dew point temperatures. If no intercoolers are employed the top and bottom temperatures may or may not be dew and bubble point temperatures, depending upon the gas and oil compositions and quantities.

For this example, however, it will be assumed that sufficient intercooling is added to maintain the temperatures at 102 F on the top plate and 94 F on the bottom plate.

Step 5. Next evaluate the effective absorption factors for each component in the wet gas and the effective stripping factors for each component in the lean oil. The values of L/V at the top and bottom plate for this calculation are:

$$\frac{(L)}{(V)_{top}} = \frac{98.00}{79.92} = 1.23;$$

$$\frac{(L)}{(V)_{bottom}} = \frac{120.07}{113.7} = 1.055$$

The subscripts of A and S identify the lean and rich ends of strippers and absorbers for purposes of finding the effective factors. Terminal A and S values are given in Table 47.

With the values of A and S at the top and bottom plates given in Table 47, the effective values of A and S are computed and given in Table 48.

The effective absorption factors in this problem are very close to those at the top and bottom plates because of the fact that the tower was maintained at substantially isothermal conditions. If the design had been made without the intercooler, the calculations for the effective factors would have emphasized the need for using these methods for estimating the effective factors.

Step 6. With the effective factors given in Table 48, the separation efficiencies may be found. These computations of these separation efficiencies are given in Table 49 for both absorption and stripping, using four theoretical plates in both stripping and absorption calculations.

The values of E_A and E_S for the various components indicate the direction of material transfer.

Step 7. With the above separation efficiencies, a material balance is made for this absorption and stripping operation. Table 50 gives the transfer of all components.

Although this material balance differs from that obtained in Step 1 (see Table 41) as the result of the assumed absorption, it is close enough to justify not repeating the above calculations.

TABLE 50. Material balance. Example 23.

	Material in, mols/hr		Material out, mols/hr	
	Wet gas	Lean oil	Off gas	Rich oil
C_1	10		9.749	0.251
C_2	30		25.680	4.320
C_3	40		22.300	17.700
C_4	30	10	9.650	30.350
C_5	10	50	10.000	50.000
C_6		15	1.185	13.815
C_7		5	0.130	4.870
	120	80	78.694	121.306

TABLE 49.—Computation of separation efficiencies for Example 23.

Absorption separation efficiencies

	Feed, mols/hr						
	Wet gas	Lean oil			$\frac{A_e^{n+1}-A_e}{A_e^{n+1}-1}$	$1-\frac{L_0X_0}{A'V_{n+1}Y_{n+1}}$	
	$V_{n+1}Y_{n+1}$	L_0X_0	A_e	A'			E_A
C_1	10		0.0251		0.0251	1.0	0.0251
C_2	30		0.144		0.144	1.0	0.144
C_3	40		0.4475		0.440	1.0	0.440
C_4	30	10	1.358	1.370	0.895	0.757	0.678
C_5	10	50	4.51	4.535	1.00	Minus*	0

Stripping separation efficiencies

	Feed, mols/hr						
	Wet gas	Lean oil			$\frac{S_e^{m+1}-S_e}{S_e^{m+1}-1}$	$1-\frac{V_0Y_0}{S'L_{n+1}X_{n+1}}$	
	V_0Y_0	$L_{n+1}X_{n+1}$	S_e	S'			E_S
C_1	30	10	0.716	0.750	0.64	Minus	0
C_2	10	50	0.2195	0.2225	0.2195	Minus*	0
C_3		15	0.0789		0.0789	1.0	0.0789
C_7		5	0.0251		0.0251	1.0	0.0251

*The fact that both correction terms are minus for C_5 indicates that there is neither absorption nor stripping of C_5 in this separation.

CONCLUSIONS

An important step in designing an absorber by any method is estimating the values of A at the top and bottom plates. It is unfortunate that this step cannot be reduced to an exact formula that could be followed in all cases. No one generalization fits all problems. This is the point where experience is very helpful. Without experience, the designer may make several trials before hitting the right combination. The following suggestions should prove helpful:

(1) If the lean oil is relatively nonvolatile and/or if intercooling is used, the top plate temperature and the top plate liquid may be estimated by a dew point and a heat balance calculation; i.e. assume top plate temperature, calculate dew point of off gas, fill in the "void" in the dew point liquid with lean oil, assume a temperature of the vapor to the top plate, and make a heat balance to check the assumed top temperature.

(2) If the lean oil is volatile so that some of it will be stripped out into the off gas, the above procedure must be used with caution, if at all. An acceptable procedure is: Assume top temperature; make a dew point calculation on the off gas thus obtaining a partial composition of the top plate liquid; prorating the absorption of the "key" component to find amount of it absorbed on top plate; knowing the amount of the "key" component absorbed on the top plate and the percentage of this component in the liquid from the top plate, find the amount of liquid from the top plate; and check assumed top plate temperature in the same manner as above.

(3) If intercooling is not used or if other conditions invalidate the equilibrium method of estimating temperatures, the top and bottom temperatures must be estimated by prorating gas shrinkage and assuming temperature change is proportional.

With reference to the various absorption calculation methods it appears that the Sherwood graphical technique could be applied with either the Horton-Franklin or the Edmister analytical method. Such a combination would possess the good points of both methods. ★★★

(Part 10 will be published in an early issue of The Petroleum Engineer.)

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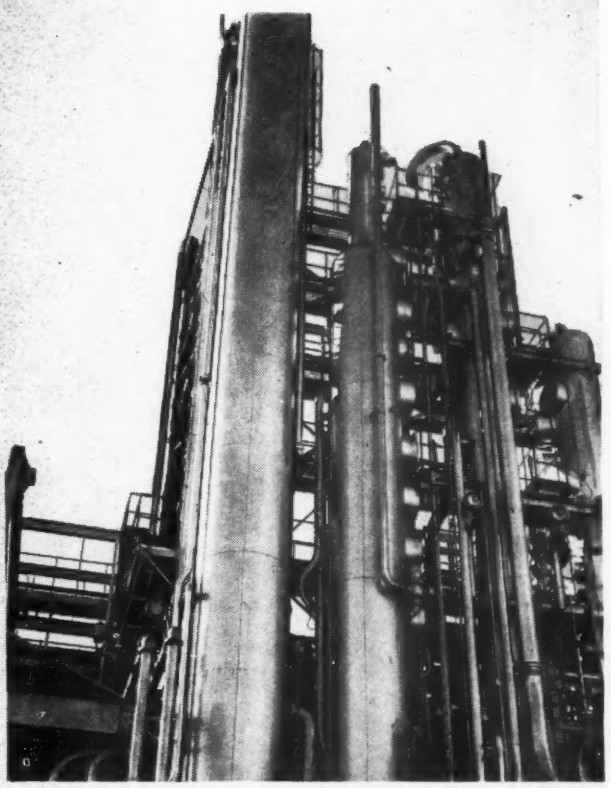

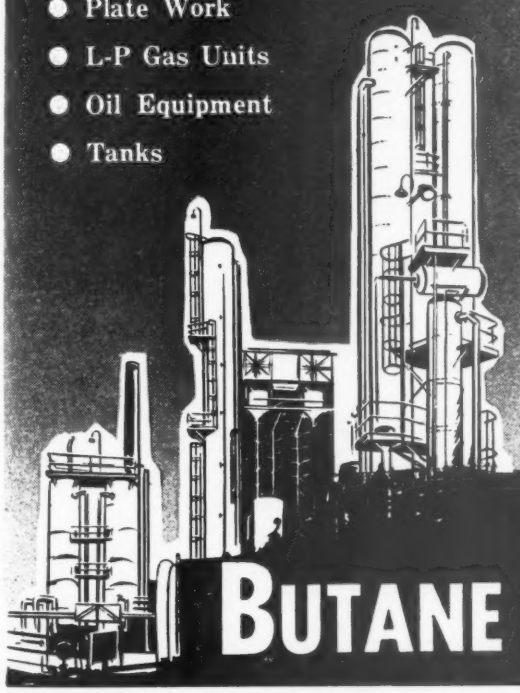

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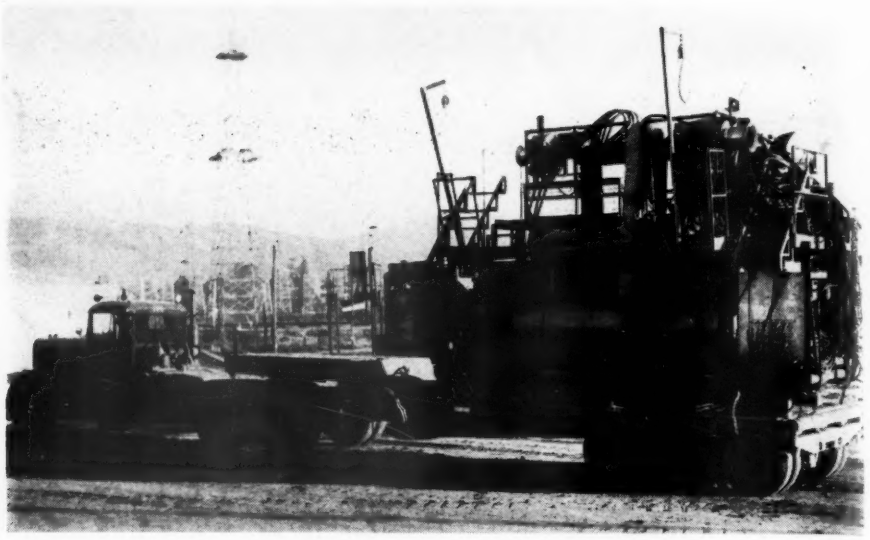

The drawworks, complete with walkways, stairs, and raised catheads, all mounted on the turntable, being transported on a three-axle semi-trailer.

Shell develops new portable electric rig

By RICHARD SNEDDON, *Pacific Coast Editor*

THERE is definitely nothing static about any phase of the oil industry, but on the ever-changing scene there occasionally appears a major development so significant as to mark a distinctive trend in a new direction, the arrival, if you please, of a new era so far as equipment and techniques are concerned. In this category may be included the recent completion and operation by Shell Oil Company, Inc., engineers of an entirely portable and exceedingly modern electric drilling rig. It is probably the first fully portable 900-hp unit ever built, and was designed to drill to depths of 10,000 ft. Neither complete portability nor 10,000-ft holes, of course, are new, but this rig features so many design innovations affecting ease of operation, accuracy, safety, and cost, and the innovations are in most instances so daringly conceived and so unusually contrived that the whole enterprise becomes one of more than ordinary import.

EXCLUSIVE

It is difficult in such a program to separate oneself from convention and preconception, but it appears that the Shell engineers did a good job of simply defining the basic requirements without regard to precedence, and then prescribing the most effective mechanisms to meet these requirements. S. F. Bowlby, vice president, under whose executive impetus the rig was engineered, points out that the specific objective of this study was to develop a portable drilling unit for use in the hilly areas of the coastal division, and the Ventura Avenue section presenting as it does exceptionally difficult conditions was deemed the ideal spot for a proving ground.

It took two years of concentrated effort to work out the details, eliminate the bugs, and bring to completion the first unit. It cost $250,000, which is roughly $65,000 more than the cost of a conventional rig of the same capacity. It is estimated, however, that despite a rising labor market and increased material costs, the new unit will save an average of $5000 per well, and that, when considered with greater simplicity of operation and added safety, is a really consequential item.

The entire project was under the direction and supervision of C. S. Penfield, general drilling superintendent, with Bill Bates immediately in charge of coordinating the divers efforts that contributed to its completion. Bill was on top of the job every minute, building and testing, shaping and reshaping, and slowly bringing into tangible form the pet ideas of all, including himself, who were involved. Responsible for some of the most interesting features was Jim Gregory, division mechanical engineer in the Los Angeles Basin, and Al Curry, construction and maintenance foreman, who was especially assigned to the job. Also deeply involved was Bill Thompson, drilling foreman, whose hobby (electricity and electronics) came in mighty handy in the installation and application of many of the control features.

The first requisite of the program was the specification of required characteristics, and the following were established as basic demands: (1) A strong, well-balanced, more easily moved mast; (2) bases of lesser weight to facilitate easier and speedier moving; (3) placing of heavy equipment in the general assembly at truck height so as to simplify handling; (4) mounting of all units and accessory equipment on wheels; (5) raising of derrick floor to permit installation of blowout preventers above ground level, thus obviating the need for a cellar, and (6) so designing, constructing, and arranging the various units that the matter of alignment of equipment and machines at proper levels is as nearly as possible automatic. It has already been remarked that the original estimated cost of a drilling rig incorporating all these features was approximately $65,000 higher than a conventional rig of the same capacity, but it was further estimated that the prospective saving in moving time alone would soon take care of the difference in initial cost.

Actually, work on the project began with the construction of a set of models, covering the mast, lightweight bases, drawworks, and drawworks turntable. With these a series of tests were conducted, and it was established that the contemplated designs were practicable and sound.

Search was then made for a drilling mast that could be moved over the highway in a single piece, and yet could be used to drill a 10,000-ft hole in quick

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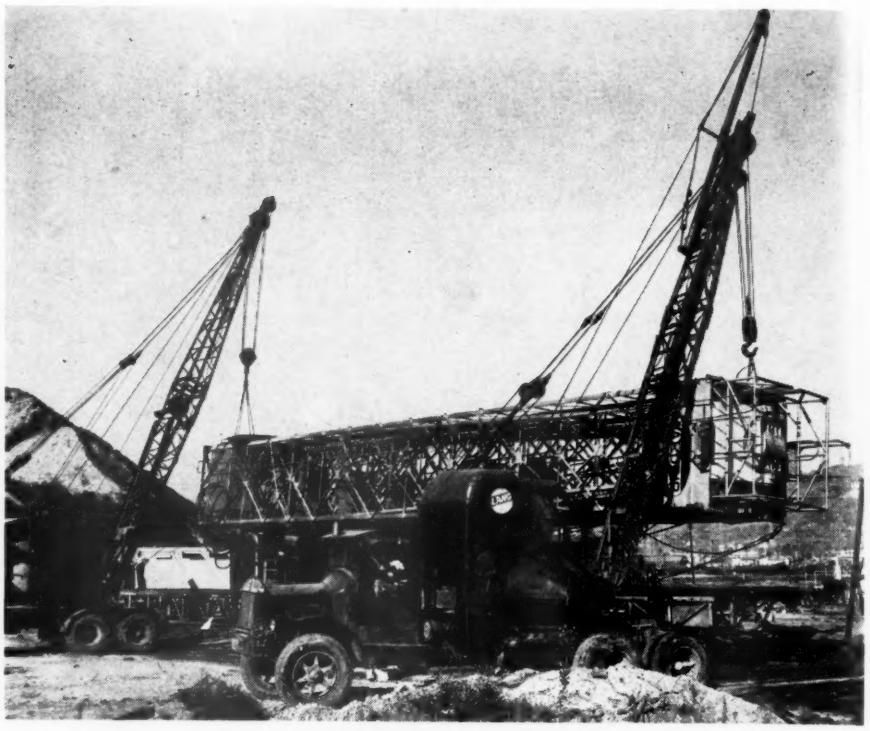
time. Nothing of the kind was immediately available, but Waldrip Engineering Company, already experimenting along this line, designed and built a two-mast derrick that very adequately filled the bill. Incidentally, Waldrip also made notable contribution in the development of bases, controls, and other special features of the drilling rig.

The placement of heavy equipment at truck height is a matter that has occupied the attention of design engineers for some time. Always, in the past, however, it has been necessary to acquire extreme ease of handling at the expense of less efficient operation, or at least to make some sort of sacrifice. Study of the problem convinced Shell engineers that to accomplish the desired result, they must either sacrifice headroom under the derrick, install the drawworks at a level considerably above truckbed height, or design a new type installation. They decided on the last course, with the final result that *the drawworks was set under the derrick floor*, and the catshaft was extended upward to the required level above the derrick floor. The drawworks with extended catshaft was designed by Emsco Derrick and Equipment Company, as also were the controls by which the driller is enabled from his console on the derrick floor to command all operations. This system of central control is made possible through the use of air clutches, hydraulic drawworks brakes, and eddy current brakes.

The reduction of the weight of the drilling bases was achieved by two distinctly radical departures from the usual practice, as follows: First, the construction of pipe wells, allowing pipe to be racked right on the ground, and, second, transfer of the weight of the rotary table to a drilling riser. The removal of these two substantial loads permitted the use of much lighter bases, and provided other contingent advantages that will be discussed later. A light welded truss, four-piece base was constructed. This can be legally moved on one semi-trailer and is sufficiently sturdy to handle all loads to which it is subject. The four-piece base also accommodates the drilling plumbing, mud ditch, and auxiliary power equipment, and is so constructed as to be capable of speedy erection with subsequent alignment of related units practically assured in advance.

The mounting of the various units on wheels was a problem of sizable dimensions (cost of wheels approximated $25,000), but it was worked to the entire satisfaction of all concerned, in cooperation with Fruehauf Trailer Company, the derrick and rig manufacturers, and others. All the larger pieces with the exception of the derrick, bases, and drawworks are set permanently on their own wheels.

By placing the drawworks below the derrick floor, extra room was obtained for the installation of the blowout preventer without the necessity of digging a cellar. Above the blowout preventer is the riser that carries the weight of the rotary table. The derrick floor is, of course, higher than normal, actually 11 ft 6 in. off-ground. A detailed account of the component units will give a more comprehensive understanding of the unusual features that combine to make this new drilling rig an outstanding example of advanced petroleum equipment design engineering.



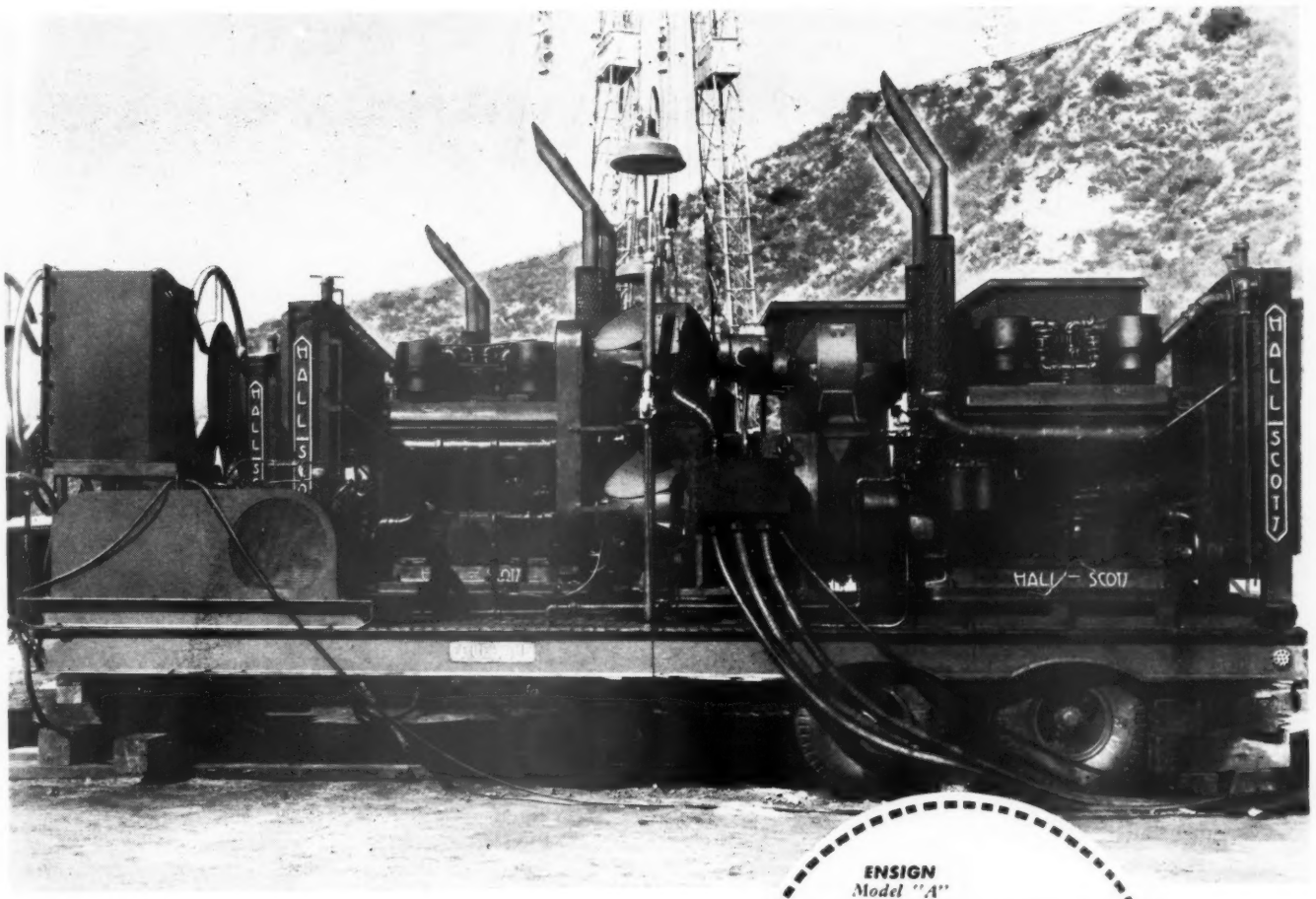
After the derrick is placed in position the cranes are no longer required. Assembly is completed in quick time and without extraneous aids.

The derrick, as may be seen in the accompanying photographs, is a twin-master of unusual character. It is 123 ft in height, but has no cross-bracing between the two legs of the A-frame. Nevertheless, it is completely stable and needs no guy line support. The lack of cross-braces gives the driller an uninterrupted view of the blocks and the derrickman. There is a 16-ft spread between the legs and the tubing platform, and the latter has capacity for the racking of 10,000 ft of 4½-in. drill pipe. The structure has a hook load capacity of 300,000 lb, can be moved over California highways legally, yet in a single package. The tubing platform is the only incidental item that has to be installed after the derrick is raised. It is carried into place by means of the traveling block.

In over-the-road position, the derrick, with the blocks strung, is compacted into a single piece of 8 by 8 by 63 ft, and weighs about 36,000 lb. The raising mechanism involves many safety devices. It consists in the main of large hydraulic rams, equipped with outlet orifices that control the speed at which the oil can be drained from the cylinders, hence at the same time control the speed at which the derrick can be lowered, even when the oil lines are disconnected. It is so designed that before the mast can be lowered to the horizontal position, the rams must raise the derrick load off the rear locking pins. This makes it impossible to lower the derrick if by some remote circumstance the rams should not be in working order.

Two electric motors, mounted in the base of the upper section, and operating through worm reduction gears, supply the power that is required to drive four sprockets that extend or telescope the mast as the occasion demands. The rotation of the sprockets causes the upper section to climb four chains mounted in the lower section. The worm gear, acting as a brake, holds the upper section in place, even when the power is turned off. Should any sort of mechanical failure threaten to drop the top section, built-in safety latches will prevent any such eventuality. When fully extended, the top section is locked securely in place by another set of safety latches.

Considerable thought has been given in recent years to the idea of mounting heavy drilling equipment at truckbed height to simplify installation and removal, and, indeed, in some respects, it has been rather extensively done. There is no doubt, however, that this is the first time anyone has raised the derrick floor (11 ft 6 in.) to get the drawworks down to truckbed level. Doing so imposed some further problems that were subsequently solved in very ingenious fashion. In the first place, some kind of remote control became essential. Secondly, the catheads had to be raised on specially built shafts several feet above the normal position, and, finally, a comparatively simple means of installing and removing the drawworks had to be perfected. Emsco Derrick and Equipment Company played an important part in the solution of these problems, and the JA-1000 drawworks used was admirably adapted to the new system.



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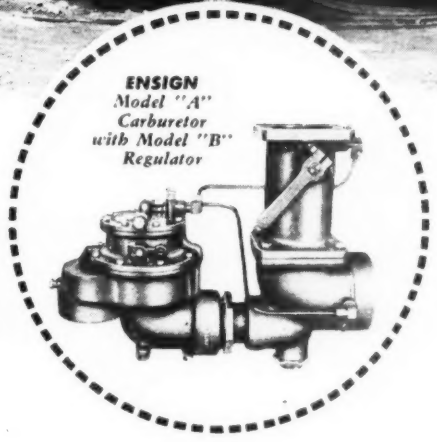

Packing a lot of horsepower into small space was a major problem for Shell engineers in designing this new portable gas-electric drilling outfit. All components including the engines, generators, draw works, slush pumps, rotary table and controls were carefully grouped on individual trailers to facilitate efficient operation and fast transportation over public highways.

To provide the most power for the space available and to make certain this power was dependable and trouble-free, Hall-Scott V-12 Defender Oil Field Engines and Ensign Carburetors were installed.

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The clutch difficulty was solved by resort to air clutches. These are controlled by simple air valves that may be mounted at any convenient place. Hydraulic drawworks brakes were found to fit the occasion, also, but it was first necessary to develop a process of remote control. This was done by using a high pressure boosting pump with valves to control the pressure applied to the brakes. The biggest headache in this department was how to exercise speed control over hoisting and rotary table electric motors. Such controls normally require rotation of the rheostat a full 330 deg in order to obtain a wide range of speeds both forward and reverse. Success was achieved in this instance, after a great deal of experimentation, by using hydraulic truck controls, together with conventional master and slave hydraulic controls. To utilize all these controls to the best advantage and with the least effort, a control desk was built toward the side and rear of the derrick floor. Here the driller sits like a concert organist, with the entire gamut of operations literally "at his finger tips."

To the informed person, the raised catshaft presents a distinctly unusual appearance. It projects several feet above the drawworks to a convenient level on the derrick floor. On the rotary end is an air-controlled spinning cathead, and on the driller's end is an air-controled master breakout cathead.

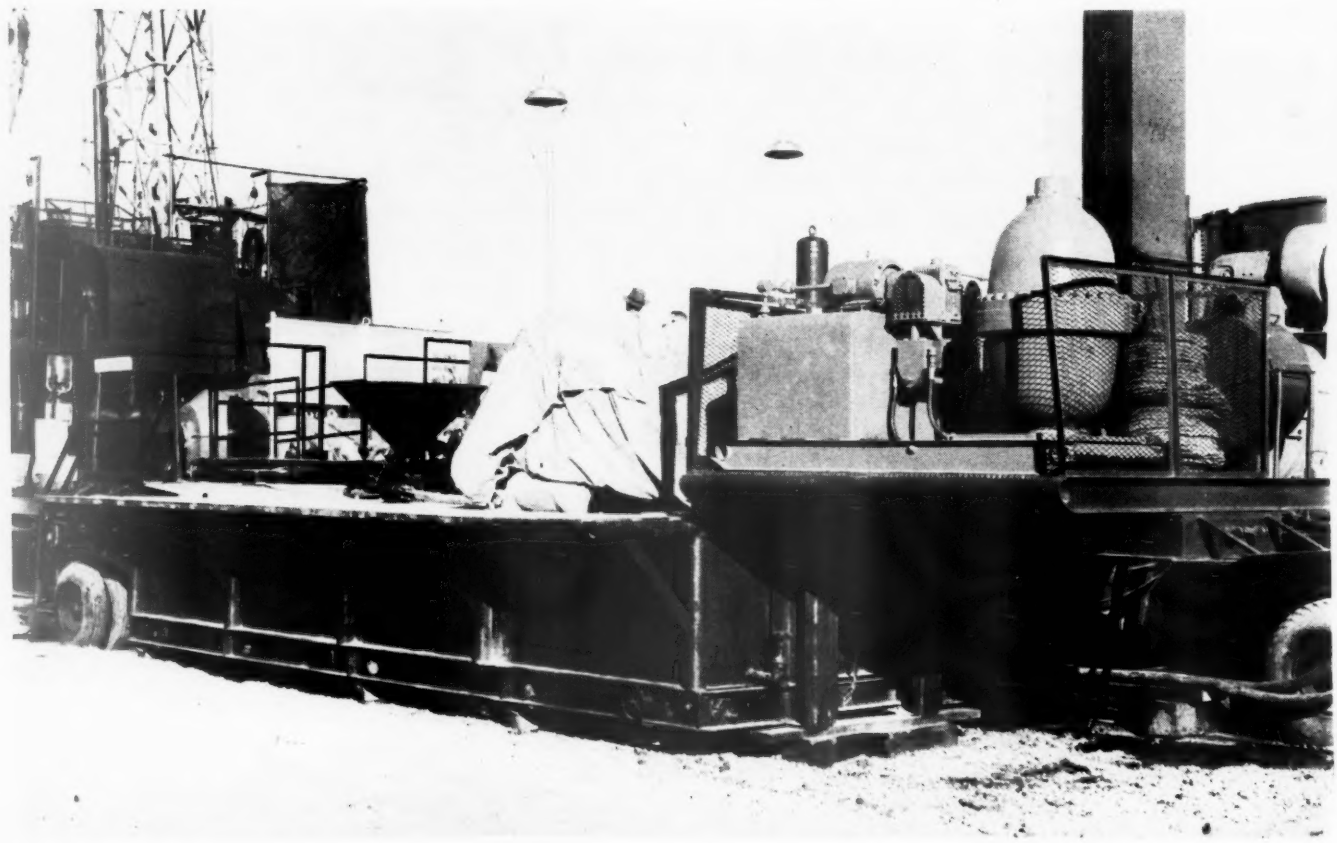
Although a part of the selective speed transmission package, the sand reel was redesigned in conjunction with the drawworks. The speed transmission package was subject to considerable adjustment and adaptation before it was brought down to the California 8-ft road width limit. A conventional sand reel with air-flex clutch was used but it was rotated through 180 deg, and a change had to be made in the drive to the sand reel. These were perhaps small matters compared with some of the changes that had to be made, but they serve to show how completely all the essential units may become involved in the effort to develop a new type mechanism.

In order that the drawworks may be placed in position or moved to a new drilling site with the minimum of effort, it rides on a permanent turntable with the pivotal point at its center of gravity. The turntable permits it to be turned very easily from its lengthwise position on the truck to the conventional cross position it must assume when in working position. When it is being installed, the truck that carries it backs into an open space between two longitudinal truss bases with the longitudinal axis of the drawworks parallel to the longitudinal axis of the truck. The drawworks is then turned through 90 deg, and the truck backs it farther into its working position. It is then picked up by hydraulic jacks, high enough to clear the truck, and the latter pulls away. Adjustable hinged legs are then dropped down from the turntable base, the jacks are lowered, and the drawworks remains securely placed on its own supports. All of which is done quite simply and without the use of cranes or other extraneous aids. When moving out, the process just described is reversed, and is also carried out without the use of any auxiliary equipment.

Drill pipe, as previously explained, is racked in a pipe well, and rests on the ground, thus taking its weight off the derrick floor and permitting the employment of lightweight bases. The pipe well is provided with a steel chute or guide, pivoted as near the table as possible. Its bottom end is movable in any direction, and the device is actuated by three jack screws, driven by remote control hydraulic motors. When a stand of pipe is being placed in the well, the bottom of the chute is first positioned. As the chute is pivotal, every stand of pipe enters at the same point with respect to the rotary table, so that the derrick floor man always releases the pipe at the same place —the place, incidentally, where it takes least effort to handle it. Also, the fact that pipe can always be discharged at precisely the same spot is an important consideration in the prospective development of a mechanical pipe breaking device.

The rotary table with a long string of pipe suspended from the slips represents a formidable weight that is normally directly imposed on the sub-bases. In addition, this load is carried directly over the hole, just where maximum clearance is desired for blowout preventers and mud discharge pipes. The Shell researchers readily conceded that some drastic change in practice would have

Double mud tank is mounted on single trailer axle. Steel beam sections are hinged to bottom so they can be swung under tank for support.



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to be made if sub-bases were to be materially lightened, so it was finally decided to support the rotary table on a drilling riser, thus taking all its load off the bases. This decision was made only after prolonged consultation with the manufacturers of blowout preventers, of rotary tables, and so forth. The table is positioned by cylindrical guides affixed to the drilling riser. The guides transmit torque loads to the riser, whence they are then passed to the bases through tie rods. While drilling surface hole, before the blowout preventer is installed, the drilling load is carried on the truss base. The cylindrical guides and independent rotary drive facilitate the removal of the rotary table when setting surface casing, or anytime a clear hole is required.

In the search for a drilling base effort was directed to the completion of one that could be built in four lightweight pieces to permit legal movement on one semi-trailer. The removal of excessive load by the two means already described made this possible of attainment. The base consists of two longitudinal truss sections about 4 ft by 4 ft by 45 ft, and two cross truss sections 5 ft 6 in. wide, 7 ft 6 in. tall and with 5 ft deep truss sections and 24 ft long. The two cross truss sections are placed 5 ft apart thus providing the derrick with a 16 ft wide by 30 ft long floor. The reduction of the central member of the cross truss section to a depth of 4 ft 6 in., a derrick floor elevation of 11 ft 6 in. is obtained. which leaves 7 ft of head room under the floor.

Conical self-aligning pins and sockets assure perfect alignment in short time and with little effort. The longitudinal bases are set parallel and in the proper location with respect to the hole center. The cross-sections are then guided into place by the conical pins. Drilling plumbing and electrical connections are conducted from the longitudinal bases to the cross truss base and thence to the derrick by means of quick-acting couplings.

The fluid pump, electric motor, and fluid reservoir tank, are carried by the lefthand longitudinal base. From this unit comes the power that operates the drill pipe racking chute hydraulic motors, also the hydraulic rams that support the drawworks while the legs are being placed in position, and the hydraulic rams that raise the derrick to the vertical. In emergency it can be used to power the drawworks hydraulic brakes and other hydraulic controls. The same base section carries the standpipe manifolding. The righthand longitudinal section supports the movable mud ditch and an air receiver.

The rotary table is driven by a 250-hp, d-c motor placed under the derrick floor between the transverse bases. The driveshaft from the motor to the table is equipped with universal joints. The table is set almost flush with the derrick floor and the lock pawls are controlled by air, from the driller's console. The use of a separate rotary table motor provides an unusually clear derrick floor, and also allows the drawworks motor to remain idle while the table is rotating.

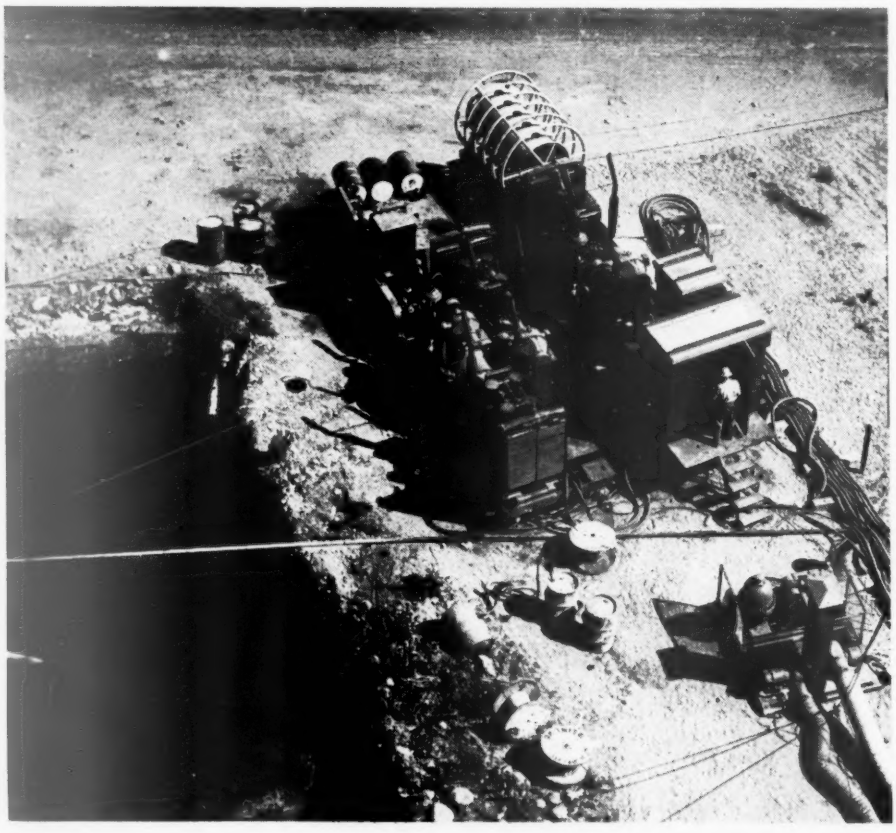
Wheels, wheels, and more wheels, is the insistent demand of portability, and yet the number of packages has been greatly reduced by the changes already indicated, so that although the number of wheels required for this entire unit seems large to the uninitiated, it is small compared with the number that was required before the changes. Actually, the only items not permanently mounted on full or semi-trailers, in addition to the ordinary tanks and racks, are the mast, which, nevertheless, is moved in a single piece; the drawworks, which, when in operation, stands on its own legs, and the four-piece sub-base.

The slush pumps and their drives have been mounted on full trailers, can be readily moved by truck, and easily disconnected and laid aside while waiting for the rest of the equipment to get under way. The pump trailers have eight 10.00 by 15 tires, are fabricated as part of the pump frames, and are very low slung—road clearance is about 12 in. Generators and their prime movers are mounted on two two-axle semi-trailers, carried on eight 8.25 by 15 tires. The drawworks motor and selective speed transmission are mounted on a three-axle trailer with twelve 9.00 by 20 tires that also carries the cable terminal board and electrical instruments and controls. The trailer is 4 ft high at the top of the base supporting the transmission, and has hinged extensions on each side. When lowered, these extensions form a platform that lies between the trailer and the longitudinal bases.

The double mud tank that serves as a pump suction tank is unusual in that it is mounted on a single trailer axle to form a semi-trailer with four 7.50 by 15 tires. The bottom of the tank supports are only 4 in. off-ground. Hinged to the bottom of the trailer are steel beam supports that are swung under the tank when it is set in place. When empty, and the front end is raised onto the fifth wheel of a tractor truck, the combination of fifth wheel lift and rear trailer spring lift clears these supports and they can be swung back out of the way.

Part of the caravan is a mud chemical tank, mounted on a semi-trailer axle, also with four 7.50 by 15 tires, and a gooseneck for hauling. This tank is covered at truck height so that dry chemicals can be unloaded from the trucks. It also carries a series of tanks for premixed liquid chemicals, and a chemical pump that is controlled from the driller's console.

The power plant, viewed from the top of the derrick, includes three 12-cylinder engines and three direct current 200 kw generators.



New Guinea operations

Shell, Standard-Vacuum, and the California-Texas companies have resumed operations in New Guinea under the corporate name of the Netherlands New Guinea Petroleum Company.

Three fields in Borneo, virtually destroyed during the war, are expected to reach record production by the end of 1948, of some 100,000 tons monthly, is the report.

a cinch

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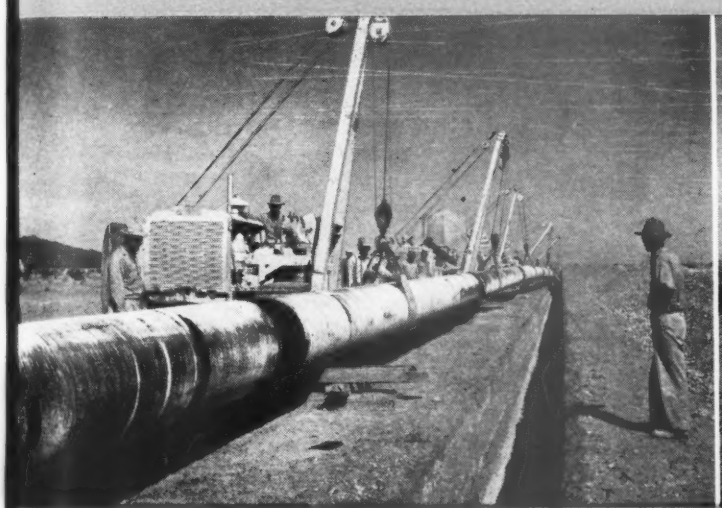
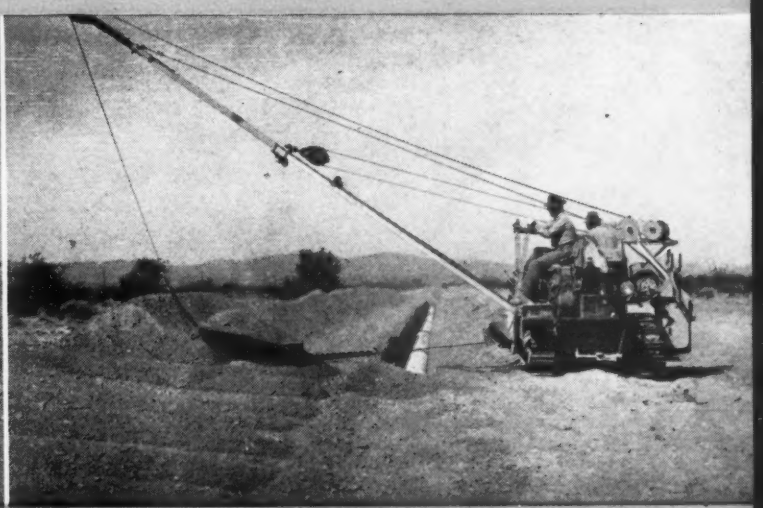
These "Caterpillar" D7 Tractors equipped with side-booms pick up pipe, carry it to trench, and hold it in place while it is being tack-welded.

This "Caterpillar" D2 Tractor pulls the welder in following the tractors that line the pipe. Also used for boosting trucks through sandy spots.



These "Caterpillar" D8 Tractors equipped with side-booms carefully lower the finished line into the trench.



The finish! This "Caterpillar" D4 Tractor equipped with drag-line backfills the trench and heap-levels the fill.

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EARTHMOVING EQUIPMENT

The convenience of adequate under-floor clearance has been provided by the unusual design of the sub-base. With an 11-ft 6-in. derrick floor, requiring no posts to support the rotary, it is possible to mount the heaviest capacity blowout preventer comparatively easily, and the 7-ft clearance under the remainder of the drilling floor gives the crew plenty of headroom while rigging up, setting blowout preventers, or performing other necessary under-floor tasks.

There is no implication here that the internal-combustion electric generator combination is the only species of drive that can be used in this type of drilling rig, but it was the consensus among the engineers involved that it was the best hook-up for their own particular Ventura operations. The terrain in which Shell Oil Company operates largely in this field is hilly and irregular, and in order to conserve space and effort it is ordinarily necessary to lay out the units in almost a straight line relationship. It is an obvious advantage, under such conditions, to be able to situate the prime movers and generators at a distance and not necessarily on the same grade, because costly excavation and preparation charges are thus avoided. These units can also be moved as an entity and connection from the generators to the control box can be made readily with electric cables equipped with quick-engaging polarized plugs and receptacles.

The prime movers and generators are mounted on two semi-trailers, one carrying a Hall Scott Industrial Defender natural gas engine, its Westinghouse 200-kw d-c generator, and the control panel; the other carrying two 12-cylinder engines, their 200-kw generators, two air compressors, and their electric motor drives. The three d-c generators are rated at 200-kw, 395-volt, 506-amp, at 1450-rpm, with separate excitation from a 15-kw generator mounted on the frame of the main generator. The larger of the two slush pumps is powered by a 400-hp, 395-volt, 820-amp, d-c electric motor, operating at 900 rpm. The smaller one is powered by a 250-hp, 395-volt, 510-amp, motor. The drawworks is powered by a 500-hp, 395-volt, 1020-amp, d-c motor, operating at 750 rpm, and the rotary table powered by a 250-hp, d-c motor.

All three generators are compounded into the drawworks motor during normal hoisting operations. In drifting, it is necessary to compound two generators into one or both pumps, and the third supplies the power to the rotary table motor. When, during drilling operations, power is required on drawworks, the driller simply cuts one of the generators from the pumps and diverts its power to the drawworks motor.

It is the intent of Shell engineers to use direct current on all continuous duty motors, and alternating current on motors that are only used sporadically, including the motors used in raising the derrick. Due to the prevailing scarcity of small d-c motors, however, a-c motors are being employed temporarily in some places where they are not best suited to the task they have to perform, but that is expected to be corrected later. A 3-hp continuous duty motor drives the vaned hydraulic pump that supplies power to the drawworks brakes, and a separated direct current driven pump supplies power to the throttle controls.

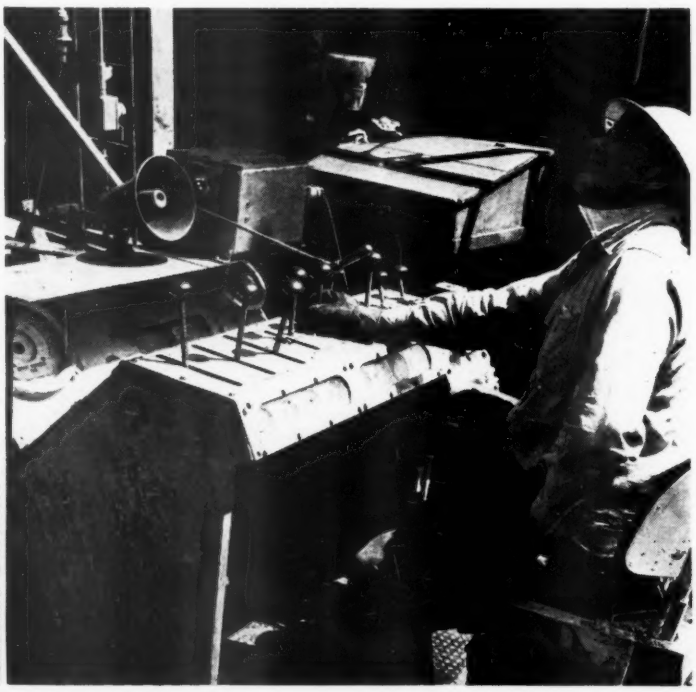
Intermittent operation is required of the 5-hp motors that extend the derrick legs, and the 10-hp motor that drives the hydraulic ram and pipe chute motors. Alternating current would normally be used for rig lighting, although direct current can be used with equally good effect. It might be mentioned in this connection that signal success has been achieved by suspending clusters of 500-watt flood lamps from the four derrick guy lines. These are so arranged as to throw an even shadowless light over all the working area, including the pipe racking platform on the derrick, the pipe rack, drilling floor, and the pump area. Four additional 200-watt lights do an excellent job of illuminating the under-floor area.

Situated some distance from the well is an independent blower unit that supplies a current of cool, gas-free air to the drawworks motor and the rotary table motor. The blower units are powered by a 3-hp and a 5-hp, 125-volt d-c motor. The blower motor and an air duct storage rack are compacted into a unitized package. Especially interesting is the fact that the "Spiri-tube" air duct collapses for convenience of moving—a 23-ft section telescoping down to approximately 4 ft.

It would be strange, indeed, if electronics failed to play some part in this

The twin-mast derrick, 123 ft high, has capacity to rack 10,000 ft of drill pipe. Working area is illuminated by 16 flood lights.

At console the driller operates this all-electric outfit from his stationary "pilot's" seat. He is aided by electronic devices.



Baash-Ross News

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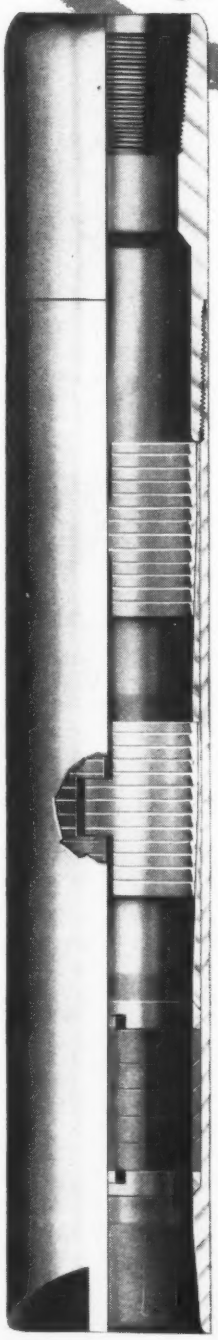
OUR 28th YEAR

Here's the tool for SIMPLE—POSITIVE—LEAKPROOF casing repairs

★ PRESSURE-TIGHT PACKING UNIT CANNOT EXTRUDE

★ DOES NOT REDUCE I.D. OF CASING STRING

★ DOES NOT DISTURB CASING CEMENT JOB

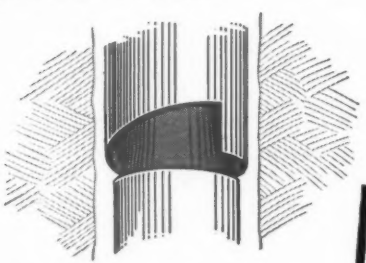


It's the BAASH-ROSS PACKING CASING BOWL

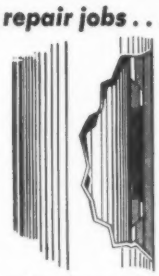
Repairing damaged or split casing strings is an easy, foolproof operation when you use this field-proven tool that has long been a dependable standby among leading operators throughout the world. It's the Baash-Ross Packing Casing Bowl—and it offers a number of important advantages on modern casing repair jobs . . .

Easy to Install!

Here's all you do to make a quick positive casing repair with the Baash-Ross Casing Bowl. First, cut the casing below the defective area (Baash-Ross makes a cutting tool that is ideal for this job!) and remove the upper portion of the string from the well. Discard the defective portion of the string, replace with good casing and attach a Packing Casing Bowl to the bottom of this replacement string. After the repaired casing string is run back into the well, it is lowered until the top of the casing standing in the hole passes completely into the Casing Bowl and seats against the shoulder in the upper portion of the Bowl.



Then the string is simply raised a short distance to set the slips and expand the lead packing to a permanent, pressure-tight fit against the casing in the well . . . the casing suspended at the surface in the usual manner to retain the tension . . . *and the job's done!*



FOOLPROOF PACKING ELEMENT

Note in the cutaway view of the Packing Casing Bowl how the upper and lower steel rings that retain the lead packing elements have a compressible joint like a piston ring. This permits them to close around the pipe along with the lead as it expands, thus preventing the lead from extruding out of the packing area. Result—a tight leakproof pack-off between the old and new casing sections, without need for cementing or other complicated sealing operations!

FULL INSIDE DIAMETER

Another important advantage is that the *minimum* inside diameter of the Baash-Ross Casing Bowl is equal to that of the Casing to which it is attached. Any tools, liners or other equipment that will pass through the casing string will also pass through the Casing Bowl without hanging up!

CEMENT JOB IS UNAFFECTED

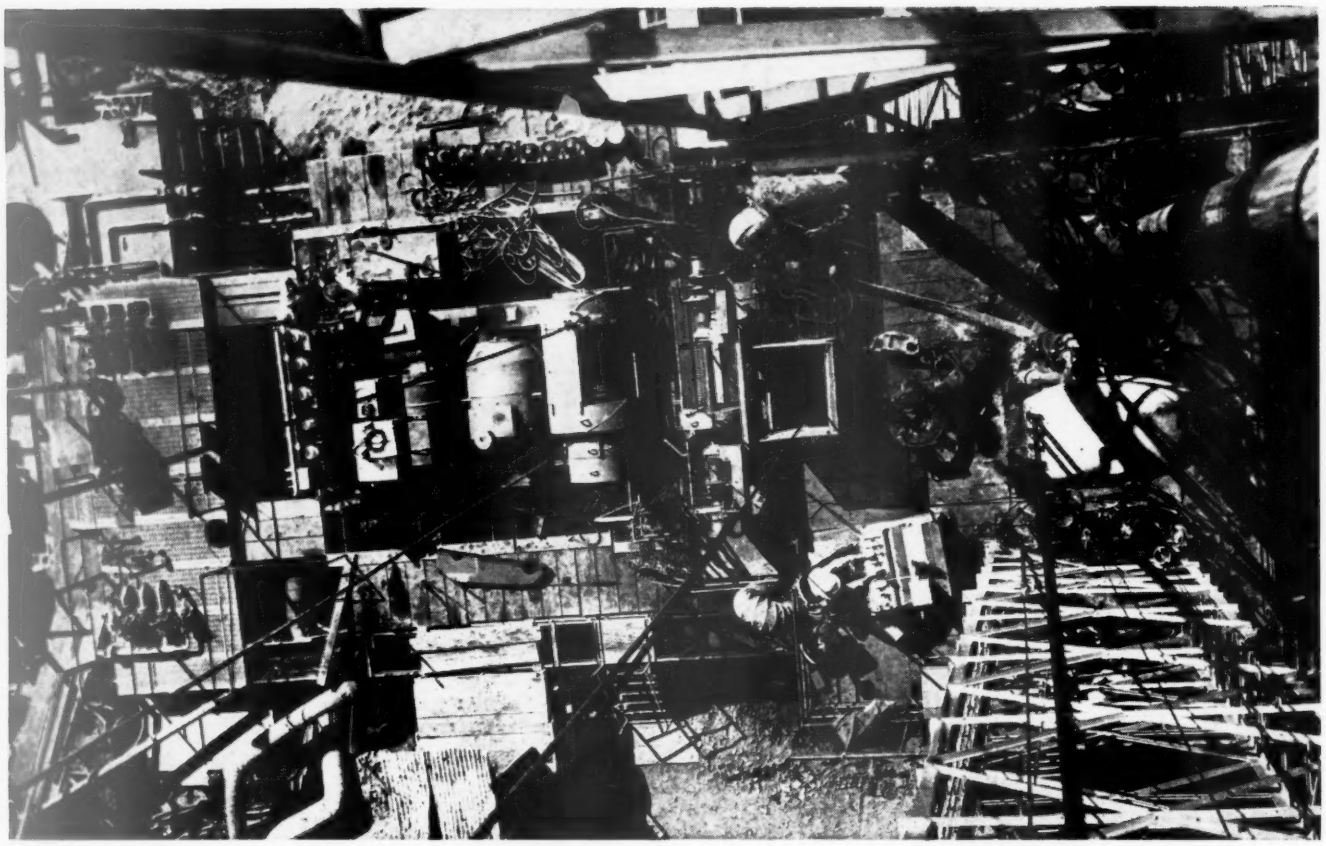
Since the Packing Casing Bowl attaches to the top of the casing standing in the hole, the cement shut-off around the shoe is not disturbed. This, coupled with the tight leakproof joint effected between the Casing Bowl and the casing in the hole, assures the repaired string being just as watertight as the original casing job.

TWO TYPES—FULL RANGE OF SIZES

Baash-Ross Packing Casing Bowls are available in two types—one with a *single* set of slips for gripping the top of the casing in the hole for use with short strings of casing . . . and the other with a *double* set of slips where extra gripping efficiency is desired on longer casing strings. In both types the packing element is essentially the same.

Both the Single and Double Slip Types are available in a complete range of casing sizes. In each size the O.D. of the Casing Bowl is not much greater than that of the casing joints, so that it can readily be run inside the surrounding casing of standard casing programs. Made of heat-treated alloy steel, each size of Casing Bowl has ample strength to withstand the most severe strains and pressures with a high safety factor.

Available through leading supply stores



The derrick man's view of the rig floor showing the hoist, mud suction tanks, the chemical trailer as well as the driller at the console.

highly modern development, and examination discloses that the youngest science is not overlooked. There are three electronic devices on the rig, as follows: Mounted on the drawworks drumshaft is a Dynamatic Corporation eddy current brake. This provides a wide range of braking control, which together with the safety features of air clutches assures the certainty of remote handling, and completely minimizes the chance of improper adjustment, or other type of brake control failure.

Another eddy current device, made by the same manufacturer, controls in proper relationships rotation speed, the weight on the drilling bit, and the rate of penetration of the drill. This instrument is placed on the selective transmission trailer. The driveback from the drawworks is through conventional driving chains and through the electric motor into a 20.4 to 1 gear increaser, which gives an overall reduction of 1000 to 1 between the drumshaft and the Dynamatic coupling. The coupling is mounted on the output of the gear increaser, and by controlling the intensity of current in the coupling, it is practical to control the rate of feedoff or the torque on the drumshaft that defines the weight actually carried by the bit.

A third electronic development used on the rig is an Ethco electronic weight indicator. Through an electric strain gauge placed on the traveling block clevis, this device determines the hook load by the elongation of the gauge itself. The strain indication is transmitted by electrical cable to an electronic box situated near the control on the selective transmission trailer. A 1000-cycle a-c full bridge system is used and voltage can be regulated to within two volts over a range from 95 to 130 volts. The power to the system is supplied by a 110-115-volt, 250-watt, 50-60-cycle alternating rig system.

Weight indications on the dial of the electronic recorder used on this rig are in increments of one-tenth of an inch of dial space, each equivalent to one ton of hook load. The load indicated is quite independent of the number or size of the lines strung, for it is a direct reading of the hook load.

The rig includes two slush pumps—a triplex 7¼-in. by 12-in. is mounted on one trailer with the 400-hp motor, and a 7¾-in. by 16-in. pump is mounted on another trailer with the 250-hp motor. The entire slush pump drives, as previously noted, are permanently mounted on their own wheels. The units are assembled so that the pump motor, V-belt drives and guards, come within legal requirement for road width. Quick-acting couplings connect the pump to the mud suction, and the pump discharge to the mud manifolding system. The suction line carries an offset connection, sliding tank section, and Dresser coupling, while the discharge lines are fitted with ball joints. This method of hookup allows the drilling crew between 6 and 8 in. of misalignment in three directions between the pump trailer and the mud tank, without serious consequence.

The two pumps have flooded suctions and a suction line in each case less than 2 ft in length. The mud tank assembly includes dual manifolding of the discharge lines and flexible connections through ball joints to all derrick base lines. Rapid emptying and cleaning of the tanks is facilitated by the use of large volume, quick-opening valves, and foot-operated valves, incidentally, are used on the flood suctions of the pumps.

The mud ditch and the mud tanks are connected by a section of canvas ditch about 3 ft long, which is supported on sliding steel hoops, and is flexible enough to take up any misalignment between the two units. The mud tank is divided so that each pump has its own compartment, and a movable mud ditch may be used to divert the returning stream from one compartment to the other as desired. This arrangement provides a means of treating the mud in one side while that in the other side is being circulated.

Looking at the entire matter objectively, the completion and economical use of this drilling rig with all its innovations is a distinct triumph in engineering design. It is the result of a species of forward thinking for which oil men have long been noted, and with which the industry appears to be sufficiently well equipped to take care of any engineering problem that the future is likely to present. ★ ★ ★

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LP-Gas sales gain 30 per cent in 1947

By R. W. THOMAS* and K. W. RUGHt, Phillips Petroleum Company

THE liquefied petroleum gas industry continues its rapid growth. Within the last three years the total sales of the industry have more than doubled, reaching an estimated total volume in 1947 of 1,845,000,000 gal. The estimated increase in volume sold in 1947 over 1946 is almost equal to the total volume sold in 1941, the last year of normal activity preceding World War II. Liquefied petroleum gas in all its uses is experiencing a greater and more widespread demand and acceptance than in previous years. By no means was the market demand for liquefied petroleum gas satisfied during the past year. The volume sold was limited by a combination of several factors, such as insufficient production of appliances and utilization equipment, shortage in transportation facilities, and inability to obtain necessary materials to construct additional facilities for production of liquefied petroleum gases. A large unfilled demand for these products continues to exist and can not be fully satisfied until these shortages are overcome.

● **Domestic use up 31.8 per cent.** The estimated increase in the volume of liquefied petroleum gas sold for domestic purposes in 1947 over that sold in 1946 exceeded the industry's total sales for domestic use in 1941. It is estimated that sales for domestic purposes in 1947 will exceed 1,000,000,000 gal. This is greater than the industry's total sales for all uses in a year as recent as 1944 and it is almost equal to the total volume sold by the industry for all purposes two years ago. These figures indicate the tremendous demand for liquefied petroleum gas for homes, institutions, and commercial establishments situated beyond the gas mains. It is estimated that at the close of 1947 there were approximately 4,500,000 homes using LP-Gas for household purposes. This means that approximately 20 per cent of the homes using gas, whether natural, manufactured of LP-Gas, are being served by the LP-Gas industry.

*Manager, Research and Development Department, Phillips Petroleum Company.
†Manager, Philgas Division, Sales Department, Phillips Petroleum Company.

The Authors

R. W. Thomas K. W. Rugh

Utilization equipment and appliances continue in greater demand than can be supplied by the manufacturers. There apparently is sufficient capacity for producing utilization equipment and appliances to satisfy the demands of the industry, but the shortage in steel and other raw materials is postponing the day when ample supplies will be available to satisfy prospective users' requirements. Despite the fact that the demand for liquefied petroleum gas appliances was not met, startling increases were made in appliance sales to LP-Gas users in 1947.

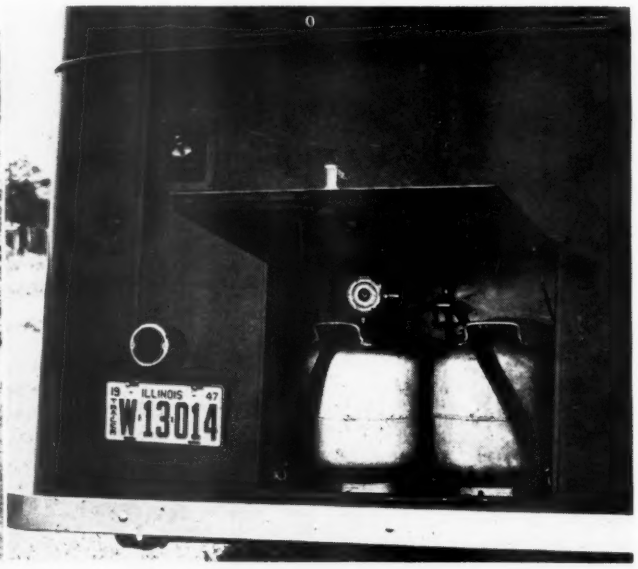
It is estimated that approximately four times as many automatic water heaters were sold for LP-Gas in 1947 as in 1946. Probably 20 per cent of the total automatic water heaters made in 1947 went to LP-Gas users. It is believed that in 1946 only 10 per cent of the total automatic water heaters produced went to LP-Gas customers. This demand for the convenience of hot water in the household was foreseen at the end of the war and it is gratifying to the industry to find LP-Gas bringing this convenience to so many more of the homes that it serves.

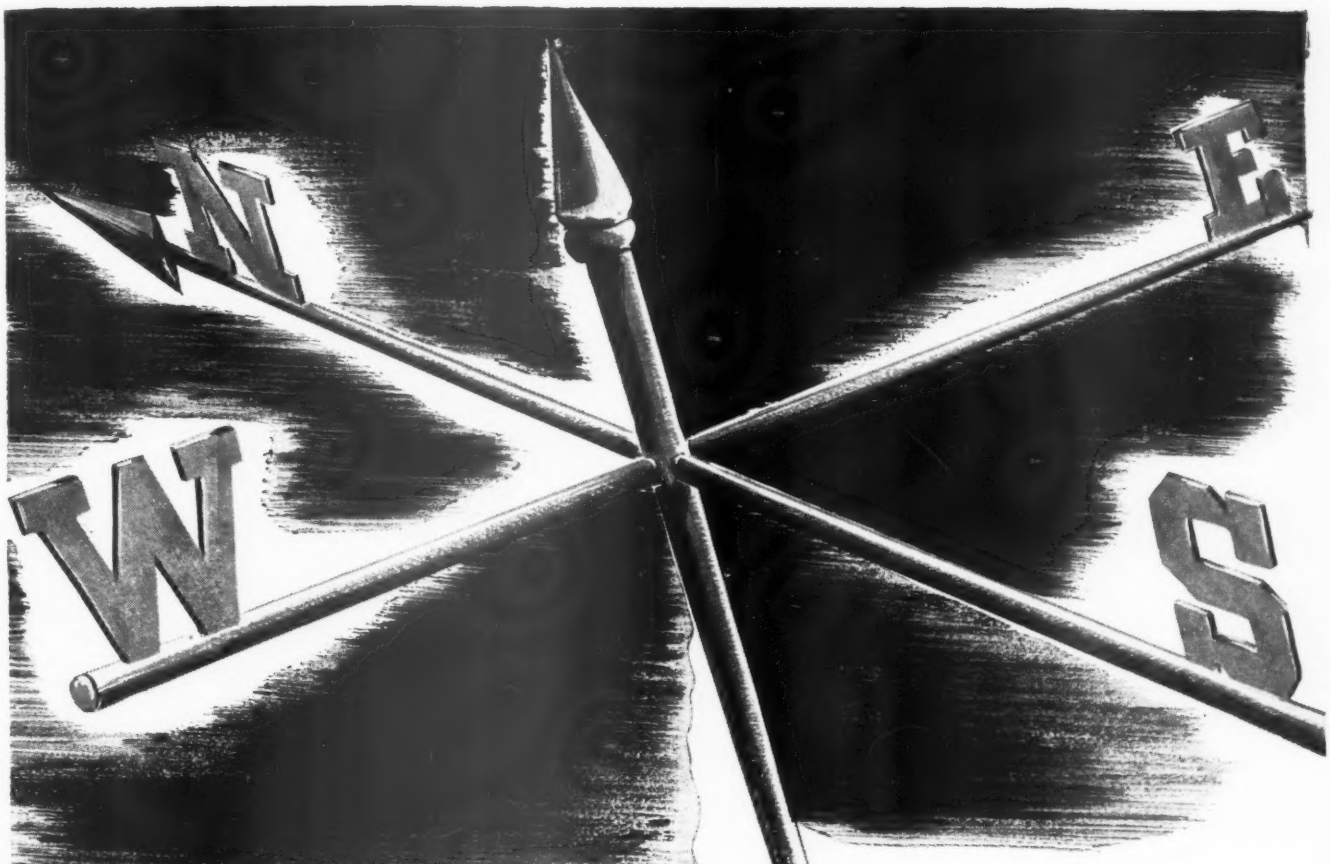
Indications point to twice the sales volume of household LP-Gas refrigerators in 1947 as in 1946. The demand for these appliances was far from satisfied even though the number sold was doubled over the previous year.

It is estimated that 25 per cent of all

LP-Gas powered heavy-duty dump truck.

House trailer installation using ICC cylinders.





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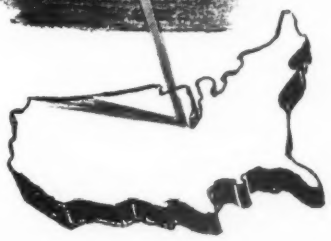

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Example of mass production methods used in filling cash and carry type cylinders.

LP-Gas tank car loading rack.

the gas ranges manufactured in 1947 were installed for LP-Gas customers.

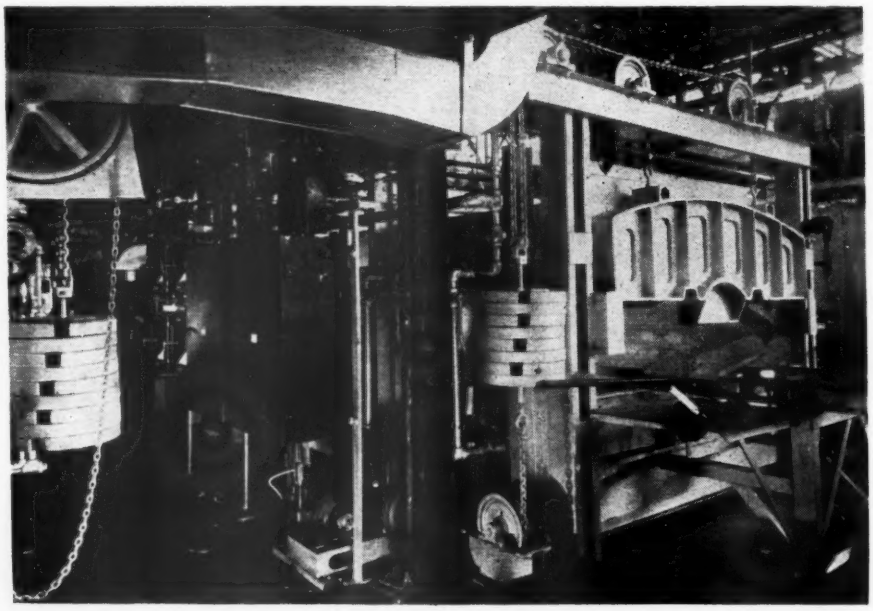
The increasing acceptance for LP-Gas for house-heating is indicated by the estimate that better than 15 per cent of the floor-furnaces manufactured in the country are made for LP-Gas. The number of central heating units connected to LP-Gas does not represent a large portion of the total manufactured; however, the demand is increasing each year.

Because of increases in all elements of operating costs and in equipment costs it has been necessary generally for the industry to increase the charges to customers for making new installations. Despite these increased charges distributors must invest more capital per new customer than formerly. Increased amounts of capital per customer are, therefore, required by the operating companies.

Higher costs in all phases of the business have resulted in the industry generally raising gas prices to consumers. Since the inception of the household use of liquefied petroleum gas, greater use has resulted in lowered costs due to increased operating efficiency and to greater saturation of customers. During the past year the upward spiral of costs has made necessary installation charge and gas price increases.

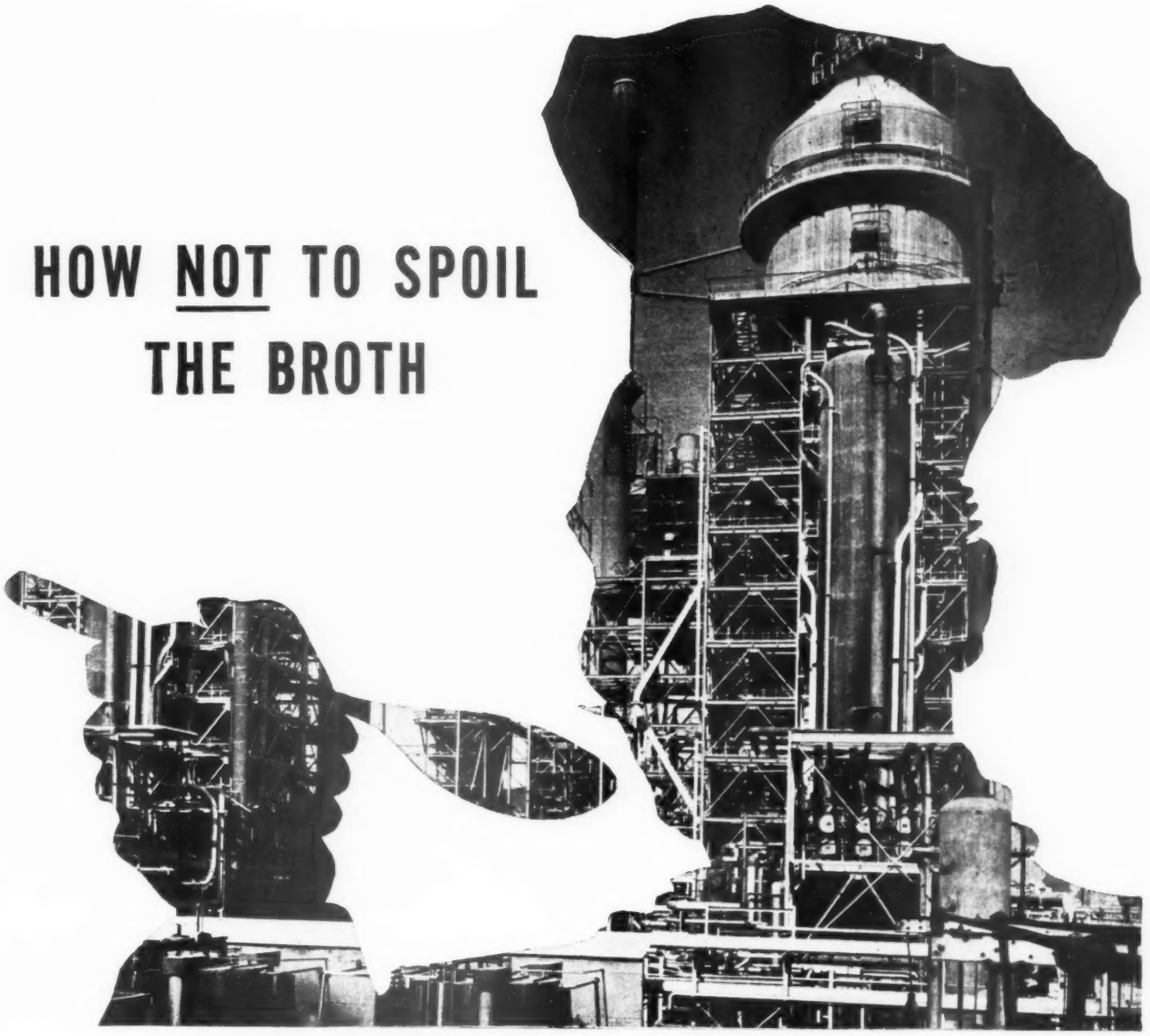
Great strides were made in increasing the storage capacity of installations for homes using LP-Gas for house-heating. Because of the inability of the industry to immediately supply the winter peak requirements of customers using LP-Gas for house-heating, experience has indicated the necessity for larger consumer storage. The industry is to be congratulated upon the results of its efforts during 1947 in installing greater gas storage capacity for domestic users.

● **Industrial use increases 11.6 per cent.** There has been considerable unfilled demand for new industrial installations. The inability of the industry to supply LP-Gas to many prospective users has limited the number of new industrial LP-Gas installations. Some increase in consumption of LP-Gas in existing industrial installations has tak-



Large LP-Gas fired furnace for heat treating automotive parts.

HOW NOT TO SPOIL THE BROTH



The old adage of *"Too many cooks spoil the broth"* certainly doesn't hold true in creative engineering.

In the petroleum industry, particularly, new processes seem to be a matter of "the more cooks the better"—for, without exception, every major step forward in petroleum refining has been the product of many minds, each contributing specialized knowledge to the same problem.

That's why we, at Kellogg, place more emphasis on the caliber and scope of our organization than we do on all the laboratories, physical equipment and patents we own—an organization which now embraces more than 1,000 topflight engineers and technicians, in every field that might have a possible bearing on the future of petroleum processing.

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Can be installed in packing cases of any manufacture.

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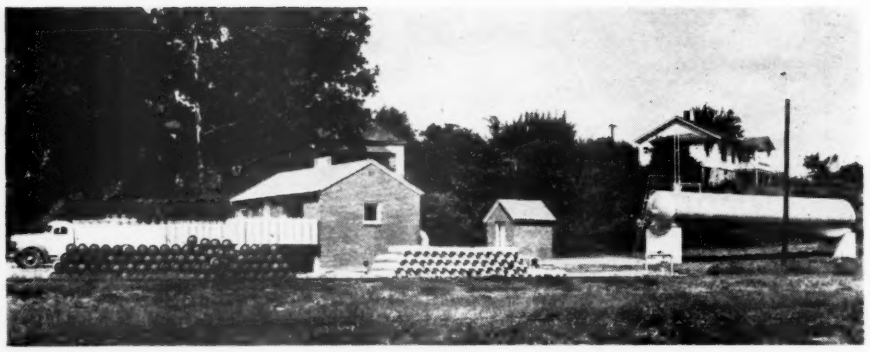


Typical bottled gas bulk plant.

en place, however, most of these manufacturers have long been operating at near capacity hence the opportunity was not great for increased gas sales during the past year to these existing installations.

Many industrial concerns normally using either manufactured or natural gas are installing "standing" storage of LP-Gas to satisfy their industrial fuel requirements during the winter months when the heating load demand experienced by the gas companies exceeds their gas manufacturing or transmission capacities and forces curtailment of gas supplied to industrial customers. The industrial use of LP-Gas for 1947 is estimated as 285,000,000 gallons, an increase of 11.6 per cent over the consumption for the same use in 1946.

● **Utility use continues to rocket.** The use of LP-Gas by utilities is estimated to have increased 55.8 per cent in 1947 over the previous year's consumption. The greater portion of this increase is attributable to the larger utility companies who are using LP-Gas to a limited extent continuously through the year to offset a shortage in supply of either manufactured or natural gas. Their principal demands have been to fill large numbers of 30,000 gal tanks, which are maintained as "standby" storage to meet winter peak load heating requirements. The interest by utilities in LP-Gas during the past year has been unprecedented and from all indications will continue. Utilities are finding that it is less expensive to install LP-Gas facilities and use LP-Gas for augmenting their present

Marketed production of LP-Gas

Year	Total sales		Distribution—(thousands of gallons)							
	Gallons (in thousands)	Per cent increase	Domestic*	Per cent increase	Industrial and miscellaneous†	Per cent increase	Gas manufacture	Per cent increase	Chemical manufacture	Per cent increase
1922	223	....								
1923	227	24.4								
1924	376	36.0	Sale of liquefied petroleum gas confined primarily to bottled gas business prior to 1928							
1925	404	7.2								
1926	465	15.2								
1927	1,091	134.6								
1928	4,523	314.6	2,600	....	400	....	1,500	....	....	....
1929	9,931	119.6	5,900	126.9	1,500	275.0	2,500	66.7	....	....
1930	18,017	81.4	11,800	100.0	2,200	46.7	4,000	60.0	....	....
1931	28,770	59.7	15,295	29.6	7,172	226.0	6,303	57.6	....	....
1932	34,115	18.6	16,244	6.2	8,167	13.9	9,703	53.9	....	....
1933	38,931	14.1	16,626	2.3	13,987	71.3	8,318	—14.3	....	....
1934	56,427	44.9	17,681	6.3	32,448	132.0	6,298	—24.3	....	....
1935	76,855	36.2	21,380	20.9	47,894	47.6	7,581	20.4	....	....
1936	106,652	38.8	30,014	40.4	67,267	40.4	9,371	23.6	....	....
1937	141,400	32.6	40,823	36.0	62,610	‡	11,175	19.3	26,792	....
1938	165,201	16.8	57,832	41.7	62,694	0.0	12,386	10.8	32,299	20.5
1939	223,580	35.3	87,530	51.4	93,723	49.4	15,435	24.6	26,892	—16.7
1940	313,456	40.2	134,018	53.1	124,482	34.5	20,285	31.4	34,671	29.0
1941	462,852	47.7	220,722	64.7	172,669	38.6	25,255	24.5	44,206	27.5
1942	585,440	26.5	303,857	37.3	197,149	14.3	31,366	24.2	53,038	20.0
1943	675,233	15.3	344,962	13.7	237,396	20.2	37,519	19.6	55,356	4.4
1944	898,071	33.0	445,617	29.0	254,590	7.3	45,879	22.3	151,985	175.0
1945	1,067,979	19.0	533,262	19.7	256,577	0.8	53,849	17.4	224,291	47.5
1946	1,415,840	32.6	766,150	43.7	255,375	—0.5	86,660	61.0	307,655	37.1
1947	1,845,000	30.3	1,010,000	31.8	285,000	11.6	135,000	55.8	415,000	34.9

*Household use plus other requirements by these customers such as irrigation pumping, tractor fuel, flame weeding, chicken brooding, and similar uses. Included also is LP-Gas sold by domestic distributors but used for industrial purposes, internal-combustion engine fuel, and for gas manufacturing purposes.

†Includes LP-Gas sold for fueling internal-combustion engines.

‡Not comparable due to segregation of chemical manufacturing.

Remarks: In this table total sales for all years except 1947, were obtained from U. S. Bureau of Mines reports. Distribution for the years 1931 to 1946, inclusive, was obtained from the same source. All other volumes were estimated by the writers. The total sales volume includes all LP-Gas (propane, butane, and propane-butane mixtures) when sold as such. Until 1944 the sale of pentane when sold for any purpose other than motor fuel blending was included. Since then it has been excluded. It does not include butane when blended with heavier petroleum fractions for motor fuel purposes. Intercompany sales transactions such as purchases of LP-Gas by one company from other companies and resold as LP-Gases have been eliminated in order to avoid duplication of sales figures. The data do not reflect sales of LP-Gases used directly by the producer at the point of production for fuel, polymerization, solvent de-waxing, etc. Neither do the figures include sales of hydrocarbons to plants manufacturing synthetic rubber or aviation gasoline or their components.

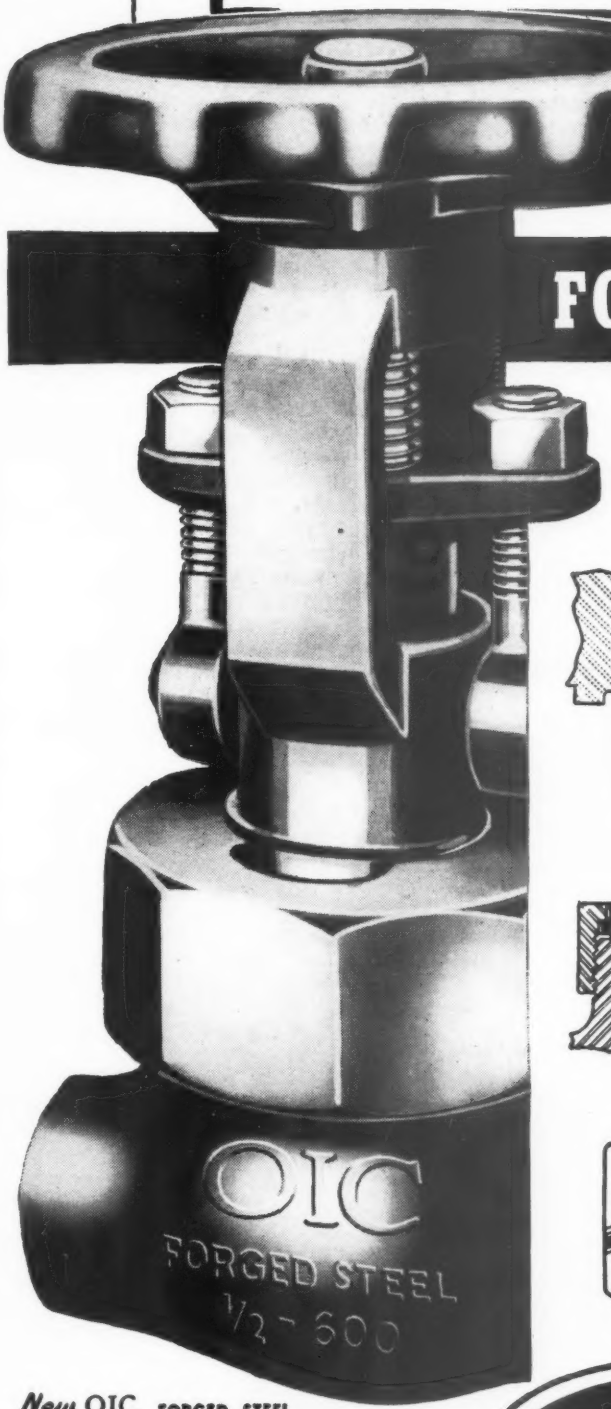
OIC

PACE-SETTER IN VALVES

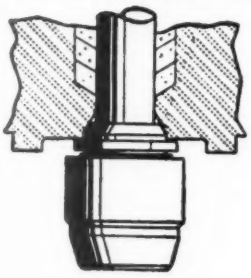
Announces

A NEW LINE OF

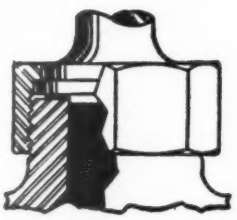
FORGED STEEL VALVES!



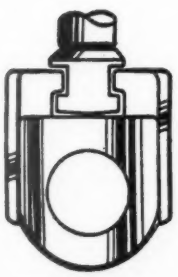
THE same superior quality that earns OIC the title of "Pace-Setter In Valves" is now available in OIC 600-pound pressure Forged Steel Valves. You'll find bodies and bonnets of this new OIC line precisely machined from carefully designed forgings . . . ample wall thicknesses maintained for greater strength and safety . . . in all types and sizes, OIC Forged Steel Valves exceed the accepted standards.



Mirror-like finish on mating back seat surfaces insures a positive, leak-proof seal when the valve is in the full open position. This handy feature permits complete removal of the packing without disturbing the flow and without danger of leakage and injury to the operator.



The stout union bonnet ring is machined from rolled steel. The octagonal design provides a greater number of wrench-grip positions and maintains ample cross-sectional area for maximum strength without excessively protruding corners. All bonnet studs and nuts are of heat-treated material — another OIC quality feature.



OIC Forged Steel Gate Valves are provided with a rugged T-head-and-slot connection between stem and disc. This connection is accurately machined to close tolerances with proper clearances allowing the disc to adjust itself to the seats without binding, thereby insuring long, dependable, trouble-free service.

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OIC **VALVES**

STEEL • IRON • BRONZE

supply for standby than to install additional manufacturing capacity or pay higher demand charges to the pipeline companies for natural gas supplied during peak demand periods only.

Because of the inability of the LP-Gas industry to make firm commitments for additional sales, there was a relatively small number of small town manufactured gas plants converted to use LP-Gas exclusively this past year. At the close of 1947 there were approximately 330 small town gas plants using LP-Gas exclusively for distribution through the mains.

● **Chemical uses continue to grow.** The use of LP-Gas by the chemical industry continues to increase principally for conversion to chemical intermediates. To guarantee obtaining these raw materials new chemical plants are locating adjacent to the points of production of LP-Gases. This has resulted in much LP-Gas being delivered either in the liquid or gas phase by pipe line from the points of production to the chemical plants. It is estimated that 415,000,000 gal were consumed by the chemical industry in 1947. This represented an increase over 1946 of 34.9 per cent.

● **Highlights of 1947.** Individual companies, national and state associations, and regulatory authorities have been active in the development of additional safety standards and in promoting safe practices. National Board of Fire Underwriters' Pamphlets No. 58 entitled "Standards for the Design, Installation and Construction of Containers and Pertinent Equipment for the Storage and Handling of Liquefied Petroleum Gases as Recommended by the National Fire Protection Association" continues to be accepted by the industry and by regulatory bodies as a code of safe practices. This pamphlet is now the basis for laws or regulations in 35 states.

It has been predicted that in five to ten years there will be productive capacity for 1,000,000,000 lb of synthetic detergents as compared to the present American soap market of about 3,500,000,000 lb.

☆ ☆ ☆

The amount of LP-Gas exported continues to represent approximately 3 per cent of this country's sales. The largest volume of these exports moved to Canada and Mexico. During the past year a dry cargo ship was converted to a propane tank ship, which is scheduled to carry propane from the Gulf to the eastern seaboard. There is an increased interest in the use of skid-tanks as deck cargo for the export of LP-Gas. Some of the present export business is moving in ICC cylinders.

There was a tremendous increase in the number of "trailer homes" that installed LP-Gas equipment in 1947. Although many of these installations were placed on mobile trailers used for pleasure and outing trips, the great majority were used to supply continuous gas service for ordinary domestic use in "trailer homes" that for the moment are stationary and are so used because of the widespead housing shortage.

There is a huge potential supply of porpane existing in gas streams but unrecovered at the present time. To segregate any significant volume of this potential supply requires much additional equipment costing considerably more than the extraction facilities that have heretofore been installed. In the case of propane obtained from natural gas sources, increased quantities are being procured generally by expensively increasing the recovery efficiencies of the extraction units to obtain a greater percentage of the propane available in the streams being processed. Frequently the added investment per gallon is as much as three times the amount invested in the past for facilities designed for lower recoveries. In the case of material procured from refineries it is usually necessary first to replace the extracted material with fuel oil or natural gas since the unextracted LP-Gases are generally consumed as fuel at the refineries. It is necessary generally for the refinery to install new extraction and purification equipment in order to produce specification products.

The increased cost of additional production facilities today is magnified by the rising costs in both material and labor. All these factors have contributed materially to the increased cost of propane. Butane has been rather completely recovered at most plants for several years. ★ ★ ★

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Detection and repair of casing leaks

By WILLIAM F. MARTIN, Texoma Natural Gas Company

EXCLUSIVE

In the Texas Panhandle, as well as in other sections of the country, production strings of casing are subject to electrical action from ground currents. Because of this action, or electrolysis, holes appear in the casing strings, usually within the top 300 ft, permitting gas to escape to the top soil and kill vegetation. This not only causes a loss of gas, but damages crops and grazing land, which damage must be paid for by the gas producer.

Heretofore, the repair of casing leaks was an expensive operation, requiring a full new production string of casing of smaller diameter than the existing production string. Due to the ingenuity of Charles I. Galloup of Texoma Natural Gas Company, however, the location and repair of casing leaks now are operations that are comparatively simple and inexpensive. The cost of repair has probably been reduced 75 per cent.

Galloup has invented a device that he calls a "casing leak detector." The device is quite simple, consisting of a metal cylinder approximately 16 in. long with wire mesh formed as a cylinder and attached to lower end of the metal tube, over which is placed a skirt of fabric that is held in place by a rubber band. In the upper end of this metal tube is a bail, to which is attached a Halliburton measuring line. It is lowered into the well by means of a Halliburton measuring device, after well pressure has been equalized; or, to use a gas field expression, "it is lubricated into the hole".

When the casing leak detector reaches the casing leak, the pressure differential at the leak pulls the fabric skirt into the hole in the casing through which gas is escaping and stops the descent of the detector. The depth of the leak is then noted and the detector is retrieved, leaving the skirt at the leak. This not only locates the leak, but temporarily stops the leak until repair work gets under way.

The accompanying sketch of this device shows its simplicity and effectiveness. The wire mesh is not shown in the sketch, but it is under the skirt, and is the length of the skirt.

After the leak is found, a short string of pipe with a packer is run, and when the packer is set the leak is sealed. The packer is set 100 ft below the leak, and the pipe extends about 20 ft below the packer to insure stability.

With this type of repair it will be obvious that a great saving will be made in steel; one of the items that is now in short supply. Instead of using, say 2400 ft of 7-in. casing in an 8-in. well, a short string of 300 or 400 ft is used with a packer. The saving in steel is from 83⅓ to 87½ per cent and it is important that steel be used as sparingly as possible at this time.

Galloup is superintendent of drilling operations, and he has had better than 35 years' experience in oil and gas fields, most of those years being with the Cities Service Company and Texoma Natural Gas Company in a supervisory position; the last 17 years being with the latter company.

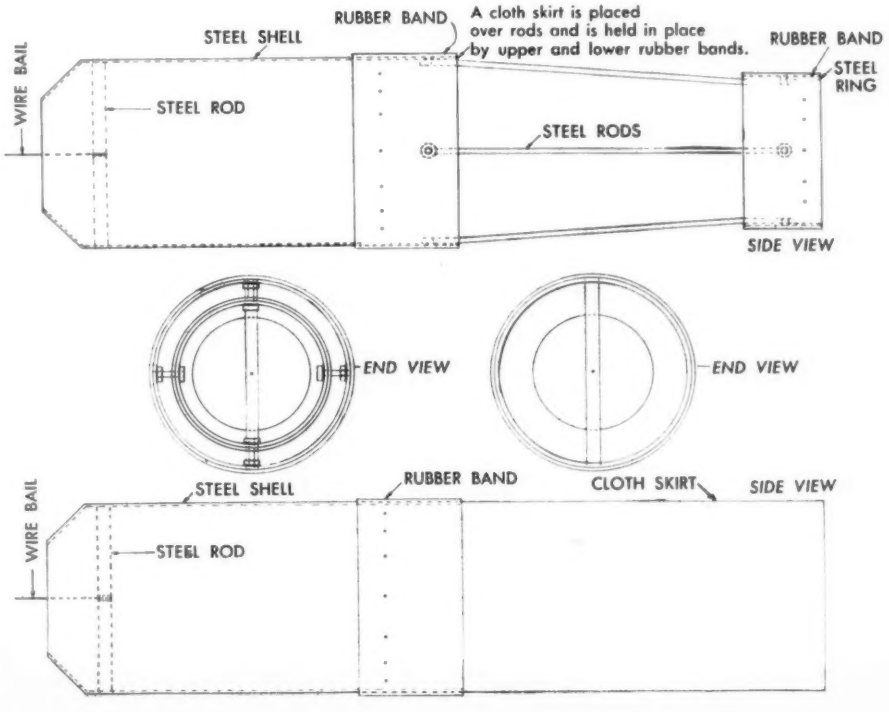
Leaks have recently been discovered in some of our wells, and they have been repaired in the manner described herein. The results have been quite satisfactory. Galloup advises that, although this detector has been used only in gas wells thus far, it will work equally well in an oil well.

Much interest has developed in this casing leak detector, and Galloup has been consulted by other companies that have leaking wells, with a view toward using his detector to locate these leaks. It is my opinion that all producers should know of this device, as a matter of economy.

● **Detection of leaks in river crossings.** Where multiple lines are used for a river crossing, it is difficult to ascertain, in the case of a leak in the pipe embedded in the river bank, which of the lines is leaking. To be able to establish definitely the location of the leak without great expense would be advantageous to a pipe line company. At the present time, it is a matter of digging out lines until the leak is found, which involves great expense. The casing leak detector can be used to locate such a leak in a river crossing. The procedure would be as follows:

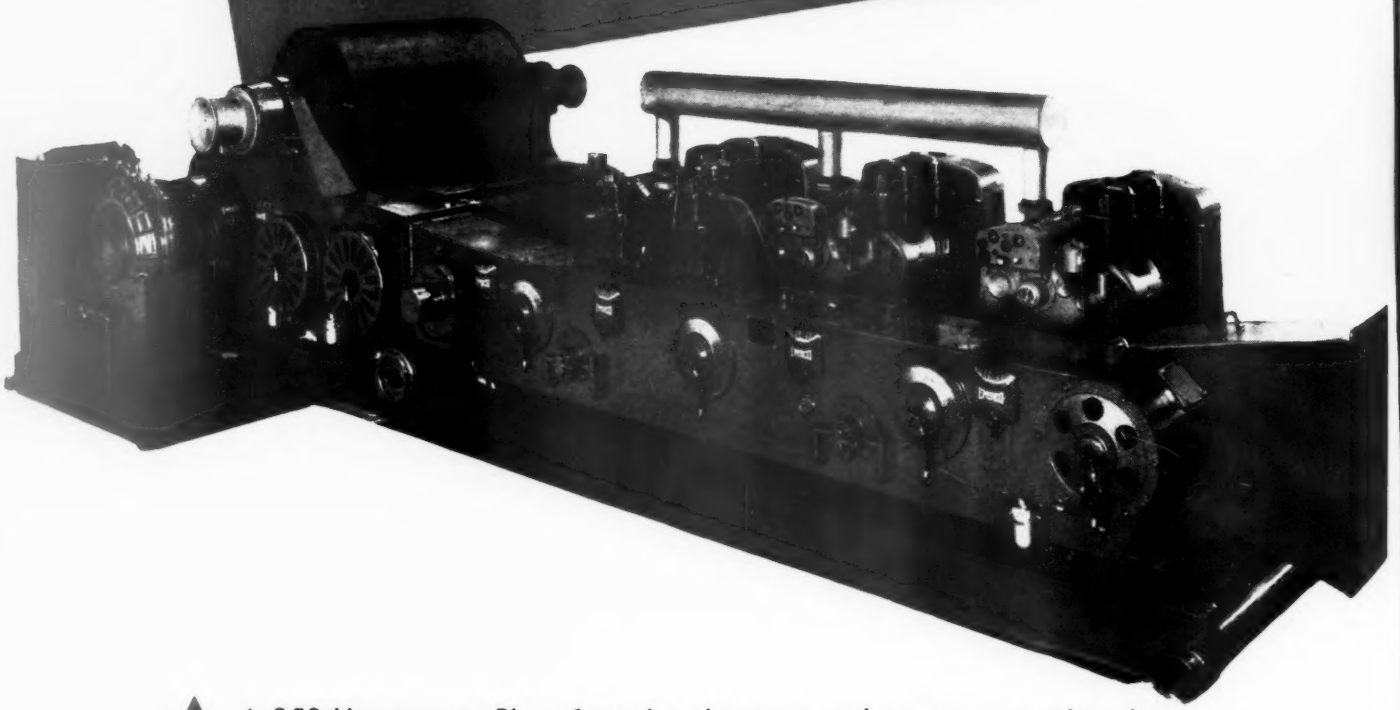
Start with Line No. 1. Set up measuring device. Attach a plug to the end of the measuring line and send this plug through Line No. 1. Detach the plug, attach the casing leak detector, and pull the detector back through Line No. 1. If the leak is in this line, the detector will be stopped at the leak and the location can be noted. If the leak is not in this line, repeat the operation with Line No. 2, and so on. ★ ★ ★

Top is multiple leak detector for gas wells and at bottom is single leak detector.



PUSH BUTTON SPEED SELECTION

THE EMSCO



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GA-350

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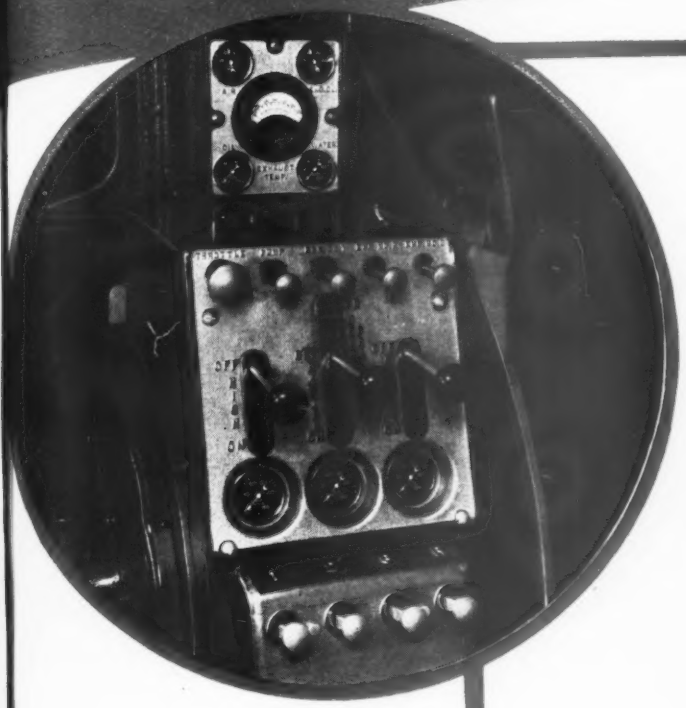
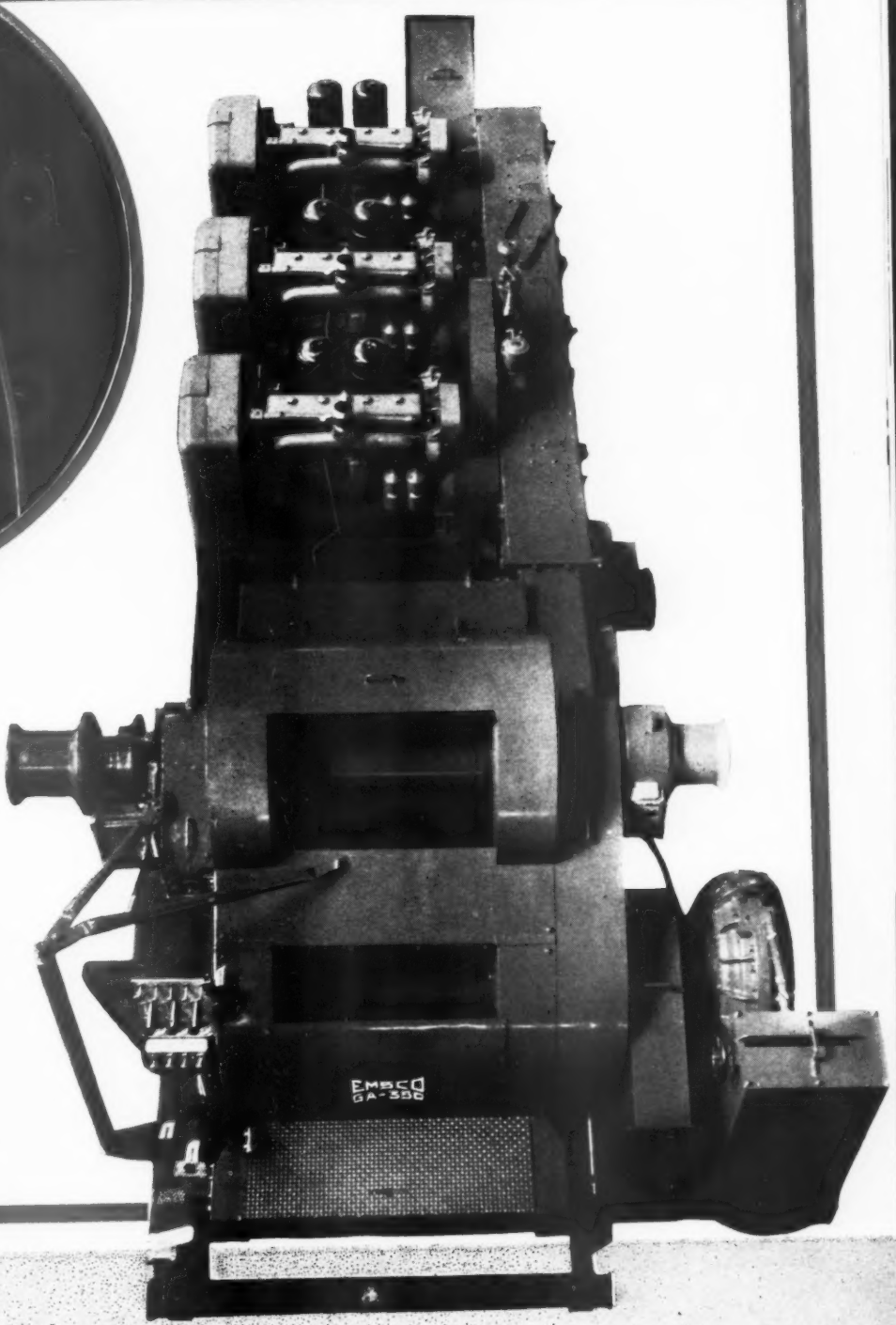
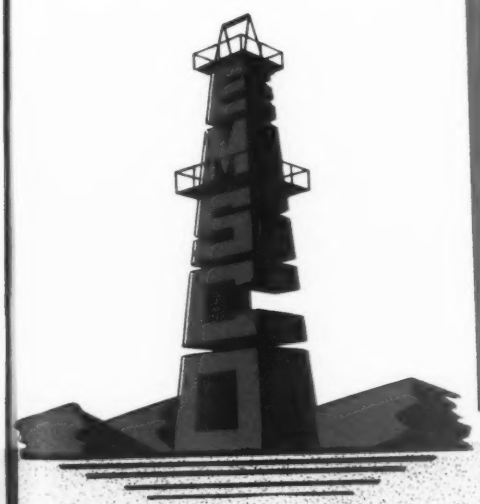






Present trends in nickel alloys*

A HEAVY demand persisted this year for alloys of all types containing nickel to satisfy the needs of the metal industry in which high production has been the keynote. A number of trends were observable that reflected the increasingly exacting demands of industry for better performance from all kinds of equipment, tools, and appliances.

● **Alloy steels.** Widespread use of alloy steels containing nickel has continued throughout the year. The railroad industry has been particularly prominent in using low alloy high strength structural steels to save weight on new rolling stock, by taking advantage of the improved strength, abrasion resistance and resistance to corrosion offered by these steels in the rolled condition. Most of the high strength steels employ nickel in amounts ranging from about ½ to 2 per cent, are readily cold formed and welded, and find extensive use in transportation equipment and other applications in which weight saving is an important consideration.

Engineering grades of triple alloy steels containing nickel, chromium, and molybdenum are also being widely employed. Aircraft manufacturers have shown preference towards the use of nickel-chromium-molybdenum steel tubing for engine frames in which high strength plus ready formability and weldability are important considerations.

Triple alloy steels of both carburizing and direct hardening grades have been almost exclusively adopted by the tractor industry for all highly stressed applications; the automotive and machine tool industries are also prominent users. A considerable market has developed for hot coiled and leaf springs because of the higher quality surface conditions and superior toughness obtainable with triple alloy steels containing from 0.50 to 0.65 per cent carbon. The American Iron and Steel Institute during the year established as one of its standard alloy steels a free-machining variety of low alloy, triple alloy steel, known as 8641. It is especially well suited for automatic screw products and combines a high degree of machinability with the good properties of alloy steels.

One of the largest consumers of nickel-containing steels has been the automotive truck and bus industry where the demands for high strength and toughness require the use of various heavily alloyed steels containing combinations of nickel and molybdenum, and nickel, chromium and molybdenum.

Recently developed low carbon high nickel steel, containing 8½ per cent nickel, shows considerable promise for use in the petroleum industry for sucker rods and drill pipe. The excellent mechanical properties developed by this steel in the normalized and drawn condition also are of advantage in this application. Another important trend in the petroleum industry has been the use of relatively highly alloyed steels for drill pipe operating in deep wells. The long strings of rod that must be handled in such wells require the use of nickel-containing steels that develop high tensile strength when heat treated by normalizing and drawing.

Piston rods of drop forging steam hammers sometimes have given short life because of the exceptionally severe impact and vibrational stresses imposed in service. In one case low carbon 3½ per cent nickel-molybdenum steel, oil quenched and tempered to a hardness of 200 Brinell, improved the average life from one week to more than 200 days.

Cast-alloy steels containing nickel are extensively used in railroad equipment, steel mill equipment, excavating machinery, and similar fields in which strength in heavy sections and toughness are requisite. They also are in substantial use in applications subject to both low and high temperature service. Low alloy nickel-chromium-molybdenum cast steels are finding considerable use for parts operating at 950 to 1000 F, not only because of their strength but because of their resistance to deterioration by graphitization over long periods of time at these temperatures. For applications involving exposure at sub-zero temperatures, castings containing about 3½ to 4 per cent nickel with less than 0.15 per cent carbon, are generally employed to avoid the brittle behavior that often characterizes other steels at low temperatures.

● **Stainless steels.** The high volume of production of stainless steels achieved during the war years has continued in the postwar period. Ingot production of more than 500,000 tons was reached in each of the years 1945 and 1946. Based on the present outlook equally high volume, or more, is predicted for the year 1947.

Industry looks forward to further expansion in volume and scope of uses in the future, and is continuing its research and development activities to provide a better knowledge of fabricating procedures and a broader consumer appreciation of the economies offered by the stainless steels in terms of lowered costs of maintenance, repairs, replacements.

Large amounts of stainless steels continue to be employed for consumer products such as kitchen and pantry equipment. including range tops, stoves, sinks, refrigerators, deep freezers, cooking utensils and other uses in the home, restaurants, hotels and other public institutions. Among the specific industries in which the use of these steels is said to show substantial growth are the air-conditioning, architectural and structural, automotive and truck, heating, plumbing, chemical, paper and pulp, textile, marine, petroleum, and the food and beverage fields. The aircraft industry, where stainless and heat resisting steels are essential in connection with the development of jet and gas turbine engines, expects to utilize stainless steels in substantial quantities.

● **Nickel and high nickel alloys.** The varied and versatile properties of nickel and the high nickel alloys, such as Monel and Inconel, are influencing their uses for many purposes involved in current advances of the various branches of science, including chemistry, aeronautics, electronics, and medicine.

Widest use of these alloys continued to be found in the power, chemical, and associated fields where new and higher standards of operating and production efficiency are forcing greater demands upon equipment. These demands include increased resistance to high temperatures and pressures and to new and more powerful agents of corrosion, such as fluorine, the industrial uses of which are just beginning to be explored. Of particular importance is the use of such alloys in the development of methods for the production of gasoline and fuel oil from natural gas.

Ability to stand up under excessively high temperatures continued to make Inconel an important material for jet engines. The same alloy's resistance to corrosion as well as its purity-protecting qualities have been growing factors governing its selection for equipment to manufacture penicillin and other modern drugs.

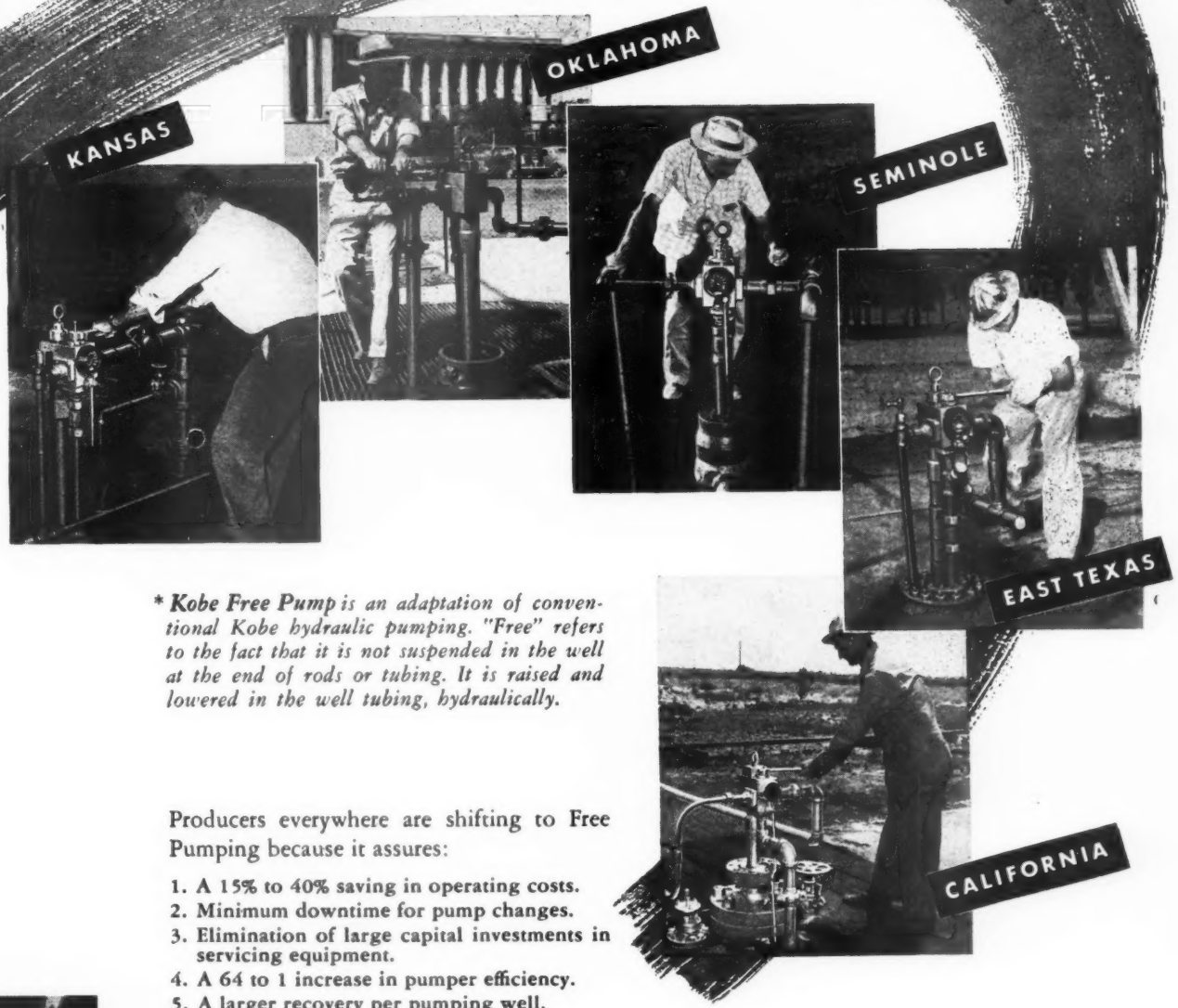
Special electrical and other properties of nickel have developed markets in the rapidly expanding field of television. Typical of this development are the nickel and nickel alloy elements used in the image orthicon, super-sensitive eye of the television camera, and in the cathode ray tubes and amplifier tubes used in the receiver.

Some of the high strength alloys, such as heat-treated "K" Monel, are aiding in the deep-well drilling for petroleum, now a major project of the oil industry. Being non-magnetic and highly resistant to corrosion, this alloy is being used for instruments as well as for actual drilling and control equipment. Producers have shown particular interest in the material because of its ability to aid in the maintenance of production levels in highly corrosive fields.

Increased interest has been noted in

*By the staff of The Development and Research Division of The International Nickel Company, Inc.

THE SWING IS TO *Free* Pumping*



* ***Kobe Free Pump*** *is an adaptation of conventional Kobe hydraulic pumping. "Free" refers to the fact that it is not suspended in the well at the end of rods or tubing. It is raised and lowered in the well tubing, hydraulically.*

Producers everywhere are shifting to Free Pumping because it assures:

1. **A 15% to 40% saving in operating costs.**
2. **Minimum downtime for pump changes.**
3. **Elimination of large capital investments in servicing equipment.**
4. **A 64 to 1 increase in pumper efficiency.**
5. **A larger recovery per pumping well.**

These are advantages that add up to higher operating profits and increased recoverable reserves. They account for the fact that entire leases are being booked for Free Pumping and why some producers are today running Free Pump bottom hole equipment in with the production tubing, preparatory to changing over to Free Pumping.

If you have not yet seen a Free Pump in action, call your local Kobe representative. Investigate Free Pumping *yourself*. Run one *yourself*, and see for *yourself* why Free Pumping is a real step toward freedom from operating cost worries.

Write for booklet giving details of Free Pumping. It will be sent without obligation to you.

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These are the days of ***Free Pumping***

the use of nickel-clad steel plate for such diversified purposes as fermenting vats and other cellar equipment in breweries to numerous applications in pulp and paper plants. A new product, also showing market possibilities, is Monel-clad strip and nickel-clad strip.

In the field of accessories, industries facing corrosion problems are turning to Monel fastenings—such as hollow, self-plugging rivets for blind working, and nails with annular grooves to give the holding power of screws.

A special type of fabricated tubing, in both nickel and Monel, is finding uses throughout a score of industries—from beer dispensing units to chemical and food processing plants. In sports, there is a marked revival of interest in high strength, corrosion-resistant alloys. Cup winners in all of the important motor boat races during the year were equipped with Monel propeller shafts.

The strong trend toward the use of Monel and Inconel in the home, which was observed immediately after the end of the war, is continuing. Applications include Monel kitchen sinks and cabinet tops as well as Monel hot water storage tanks for gas and electric heaters. There is an increased use of Inconel-sheathed heating units for electric ranges.

● **Alloy cast irons.** Consumption of nickel in cast iron, particularly Ni-Hard for abrasion resistance and high nickel-bearing Ni-Resist for corrosion-resistance, expanded substantially.

The use of abrasion resisting martensitic cast irons, known as Ni-Hard, containing 2.5 to 4.75 per cent nickel, has increased considerably and they are rendering excellent service in the mining industry where the material is used for grinding balls, mill liners, pump bodies, and impellers, and for other components subject to severe abrasive wear.

Corrosion, heat and wear resisting austenitic cast irons, known as Ni-Resist, containing 15 to 36 per cent nickel, are finding greatly increased applications as cylinder liners and valve guides for internal-combustion engines, in chemical equipment, heavy duty commissary ranges, pipe, glass molds, and bolts.

Low expansion wear resistant 35 per cent nickel cast iron is in increasing demand for precision machine tool and instrument parts.

● **High nickel irons.** During the year a new magnetic alloy was announced that affords a maximum permeability of about 1,000,000 as compared to about 100,000 for the best previously available material. The alloy, which contains 79 per cent nickel, already has been used in considerable quantities of apparatus supplied to the U. S. Navy. Its use in communication transformers has been found to permit a three-fold increase in the range of frequencies transmitted. Interest in magnetic amplifiers and frequency multipliers using saturating nickel iron cores is growing rapidly.

● **Wrought nickel silver alloys.** There has been a strong postwar demand for the nickel silver alloys, of which the 18 per cent nickel type is the most widely used. Along with the demand in the silverplated ware industries, there has been considerable utilization of this alloy for zipper stock and springs in telephone and electrical equipment. In addition, nickel silver finds many applications for watch cases, key stock, costume jewelry, and a host of other uses where a corrosion-resistant, white metal with good forming characteristics is desired.

● **Copper nickel alloys.** Cupro-nickel tubing alloys are firmly established in the marine industry. During the war practically the entire production of 70-30 cupro-nickel was consumed by the U. S. Navy in the heat exchangers and salt water lines of naval vessels. With the cessation of hostilities, these alloys became available to industry and steadily increasing successful applications are being made in the petroleum and power fields in addition to their continued use in the marine industry.

● **Nickel plating.** The record high rate of nickel anode production during 1946 included some refilling of tanks that had been depleted by war demands. The fact that the 1947 production will be higher than the 1946 record is a truer indication of the increase in the actual use of nickel for plating.

The automotive industry is still the leader in the use of nickel for plating purposes and is outstanding among a host of diversified fields. Almost all fields are showing either an increase or a favorable resumption of prewar use. Preliminary examination of large-scale exposure tests by technical societies and specific tests by interested companies have reaffirmed the value of heavy nickel layers under chromium in atmospheric corrosion resistance. Partly as a result of this, heavier nickel plates are being used by the automotive industry on areas exposed to the atmospheric elements.

Nickel plating on aluminum is increasing in popularity as it becomes apparent that reliable adhesion and thorough coverage with heavy deposits can be obtained. Chromium on nickel platings of plastics is being done in considerable amounts.

Applications other than decorative work have shown increasing activity, namely the electroforming of specific articles, building-up of worn parts, and particularly the use of heavy nickel deposits on processing equipment in the chemical engineering, and food industries. Much interest has been aroused by the availability of steel pipe and tubing lined with electrodeposited nickel.

Nickel plated steel wire suitable for redrawing and fabricating has become available in limited quantities. Electroformed screen has been employed in amounts comparable to the best prewar years, and electrodeposited foil is progressing from development work to the commercial stage. Research by various technical societies and cooperating organizations is adding to the knowledge of such properties of nickel deposits as strength, corrosion-resistance and internal stresses, and of practical means of obtaining the most desirable properties.

● **Nickel and nickel alloy coinage.** The consumption of nickel for coinage purposes from about 1880, when the first pure nickel coins were struck, to 1946, inclusive, was about 90,000,000 lb, of which 52 per cent was used for pure nickel coins by 39 countries, and 48 per cent for cupro-nickel coins of a 25 per cent nickel content by 101 countries. The use of nickel for coinage, whether in its pure state or as an alloy with other metals had to be discontinued because of the demand for other purposes during the war years, and it was not until 1945 that it began to come into regular use again for that purpose.

Despite the problems presented by the relatively low exchange values of the monetary units of many former nickel coinage countries, some of which are obliged by the depreciation of their currencies to continue using the emergency alloys introduced during the war, the general trend is again toward nickel and nickel alloys for minor coins. In two notable instances, India and the United Kingdom, pure nickel and cupro-nickel, respectively, have recently replaced silver as the standard coinage metal of those countries.

In addition to its advantages because of whiteness, lustre, and resistance to wear and corrosion, nickel possesses certain properties that present almost insuperable obstacles to the counterfeiter, and it is these features that have made it an indispensable element in modern coinage systems, whether used in its pure state or as an alloy with other metals. ★★★

Organization controls Italian methane

Studies, methods of research, production, and distribution of methane in Italy are under control of Ente Nazionale Metano, organized in 1940 with capital supplied by the Government.

President of Ente Nazionale Metano is Rag. Gian Luigi Balzarotti, and general manager is Dr. Ing. Mariano Amico. The organization is managed by a board of directors, whose members are representatives of the Government.

The objective of Ente Nazionale Metano is to advance exploration for methane sources in national territory. Methane represents one of the best resources of the Italian subsurface.

The office in Ariano Polesine (Rovigo) is outstanding in the geological field. Branch offices are situated in Milan, Bologna, Padova, Rovigo, Frenze, Ferrara; Reggio Emilia, Parma, and Piacenza with headquarters in Rome. Experienced technical men complement the well-equipped laboratories, which are used for research and production in order to bring to fulfillment Italy's production possibilities. ★★★

Coring dually completed wells

By TEMPLE P. HOFFER, Development Engineer
Otis Engineering Corporation

FIG. 1. A casing caliper that is used to measure the depth of corrosion pits and the ID of casing to a plus or minus 0.010 in. Periodic use of this tool enables operators to determine the depth of corrosion and hence the remaining wall thickness of the well casing.

EXCLUSIVE

In a previous article, "Pumping Dually Completed Wells",* a series of two-zone pumps for separately pumping the upper and lower pays of dually completed wells was described. Dual oil wells with both pays requiring artificial lift were emphasized in that article. In this article it should be stressed that two-zone pumps can be used to pump the upper pay of a dual completion that flows either gas or oil from the lower pay.

In this type of installation the lowermost segment of sucker rods and the lower pay pump are not run with the upper pay pump. The production from the upper formation is gathered from the tubing at the pumping tee, and the lower pay is flowed through the casing. In case the lower pay is oil, it is recommended that the seating shoe for a lower pump be placed in the tubing string at the time the upper-pay pump installation is made. Then, when the lower pay ceases to flow, the pump to produce the lower formation may be installed without pulling the tubing.

During the last one and one-half years some operators have requested subsurface equipment that would permit flowing the lower pay through macaroni tubing and producing the upper formation through the annulus provided by the macaroni and 2 or 2½-in. tubing. This flow arrangement has been used very effectively to lower the gas-oil ratio of upper pays by providing a more efficient flow passage than that represented by the annulus of regular sizes of tubing and casing. This provides better utilization of reservoir energy and this prolongs the flowing life of pays not making appreciable quantities of water. Other operators† have used this equipment to obtain increased production from gas wells. Several models of these flow tools have been used. Fig. 2 shows a macaroni to tubing packer that is used to land and seal in a bottom hole choke nipple. Such nipples are often installed in dual wells above the tubing packer when the tubing is run. Note in Fig. 2 that a cup-type tubing-casing packer is shown above the upper pay. This in an anchor style packer and hence has no slips. In the past, installations employing the flow tools have not made use of the upper packer. Some operators are giving much consideration, however, to the importance of protecting the casing string from corrosive well fluids and gases. The upper packer will exclude all gases, fluids, paraffin, and sand from the casing or permanent string above the packer. This arrangment will put the production of the pays into and around strings that are removable, so that inspection to detect corrosion may be made visually or with calipers. The casing annulus above the packer may be loaded with a non-corrosive fluid by use of ports immediately above the packer, if the operator desires.

Most operators are using the casing annulus as a flow passage for the upper pay production. Within the last several years the corrosive action of gases and fluids in some fields has proved to be a very serious operating problem. Calipers for detecting corrosive action inside tubing have been perfected to the point that the operator can determine the internal condition of tubing by simply running these instruments.

A casing caliper, which employs the same principle of operation as that used in the tubing caliper, has been designed and applied. Fig. 1 shows a photograph of this instrument. This caliper will measure the depth of corrosion pits as well as the diameter of the casing string with an accuracy of plus or minus 0.010-in.

Many operators of singly completed wells have used subsurface production controls for a long time. The most common of these controls are bottom hole chokes, safety valves, and pressure regulators that are installed and removed from the tubing string by use of a wire line. Bottom hole chokes are often used to prevent freezing of surface controls, reduce gas-oil ratios in certain types of production, maintain steady flow and constant withdrawal rates, etc.

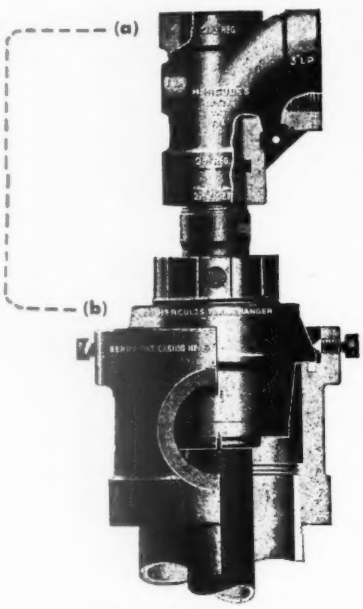
Bottom hole pressure regulators are used to prevent freezing of surface controls, to serve as a variable bottom hole choke, to reduce dangerously high flowing pressures to safe limits, etc. Subsurface tubing safety valves have been extensively applied to prevent damage caused by "wild flow" through tubing or surface connections. Hundreds of these tools have been used to protect wells and other property.

When flowing the usual dually completed well, i.e., with the lower pay produced through the tubing and the upper pay produced through the casing annulus, the operator can employ the above-mentioned production controls in flowing the lower pay. In the past, however, these controls have not been adptable for controlling production from the upper pay.

Operators and equipment manufacturers have recently devised means for using these controls, however, on both upper and lower pays in dual wells. Fig. 3 shows schematically the arrangement that permits the application of tubing chokes, pressure regulators, and safety valves to both zones of a dually completed well regardless of the type of production, i.e., dual oil, dual gas, lower oil and upper gas, or vice versa. In principle, this arrangement makes use of a special cross-over packer. Please note that the locking and pack-off section of the control installed to serve the lower pay employs a cross-over mandrel that directs the lower pay into the casing annulus. Any control desired may be screwed onto the lower thread of the pack-off mandrel. For purposes of illustration, a tubing safety valve is shown. A steel disk that serves to separate the pays is shown between the retainer nut and locking mandrel of the lower pay locking device. The control for the lower pay is

*"Pumping Dually Completed Wells," by Temple P. Hoffer, *The Petroleum Engineer*, Sept., 1947.

†"Increasing Dually Completed Gas Well Production by Reducing Flow Area," by Paul L. Shelton and T. M. Clark, *The Oil Weekly*, March 3, 1947.



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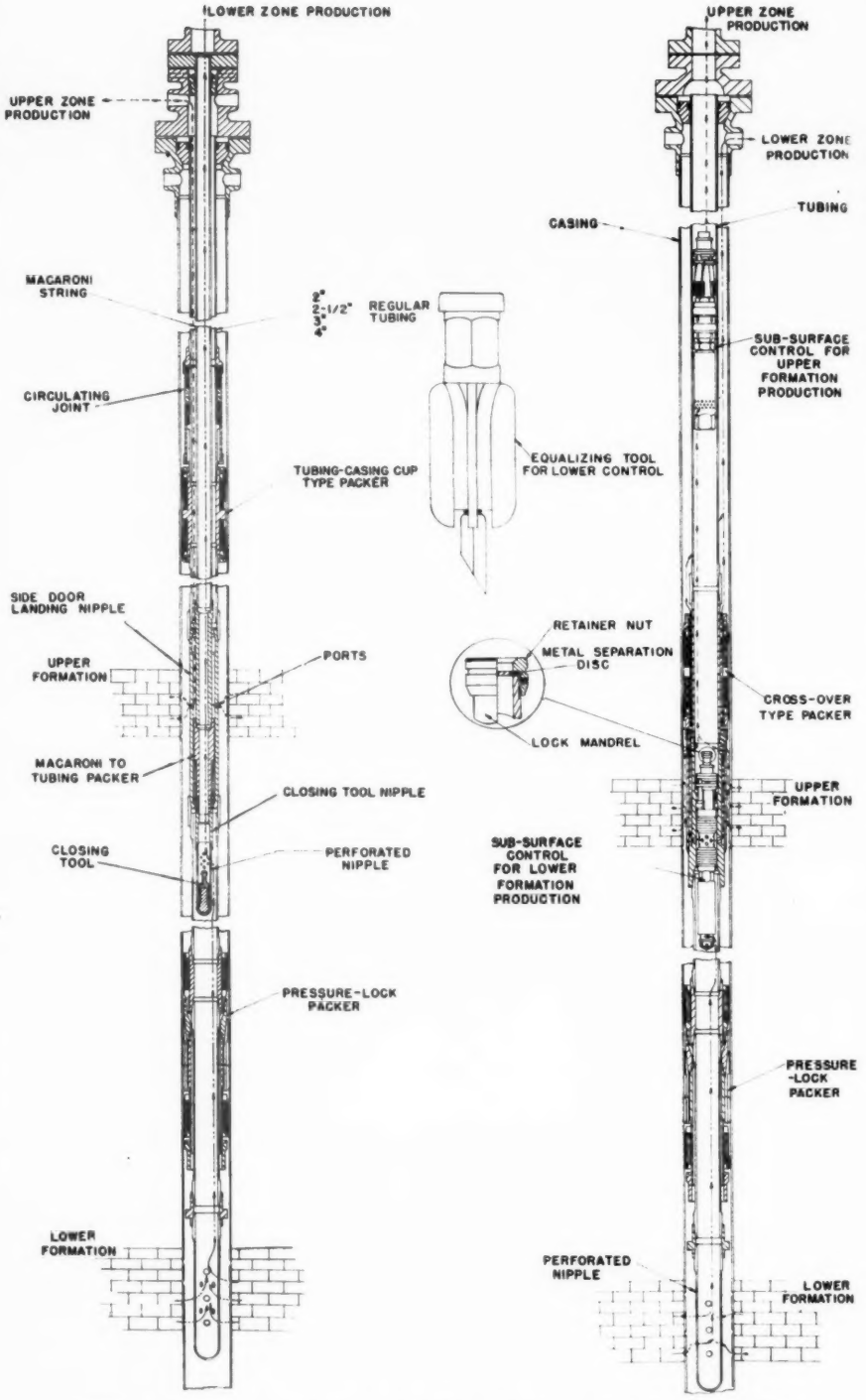

FIG. 2. (left) shows a macaroni to tubing packer that is designed to land and seal in a bottom hole choke nipple. FIG. 3. (right) shows an arrangement that permits the application of tubing chokes, pressure regulators, and safety valves to both zones of a dual well.

installed and removed from the well by a wire line equipped with the proper running and pulling tools. The separation disk is reptured prior to pulling the lower tool by use of the sharp prong in order to connect and equalize the pressures of the pays. The upper part of Fig. 3 shows a control that serves the upper formation. This may be another safety valve or subsurface choke, etc. For purposes of illustration, a pressure regulator is shown. This upper control may be placed at any point in the tubing string above the upper pay, and the locking device may be of the type shown, which uses locking dogs to lock the control in a recess in a landing collar place in the tubing string, or it may have slip-type dogs to lock at any point in the tubing string.

The equipment discussed in this article is representative of tools that have been used recently or will be used in the future to enable operators to produce dually completed wells more efficiently. ★ ★ ★

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Rehabilitation of Dutch Indies oil fields*

THE following is a review of conditions in the various oil fields of Borneo, Sumatra, and other parts of Indonesia, together with present and prospective production figures.

● **Borneo.** *Tarakan.* The plants and fields at Tarakan were totally destroyed during the war. Rehabilitation began even before the Japanese capitulation. In October, 1946, a beginning was made with the drilling of new wells. In October, 1947, the new wells were ready.

Production until the end of September, 1947:

January, 1947	18,000 tons
July, 1947	24,000 tons
September, 1947	21,700 tons
Total number of wells in September, 1947	313
Number of employes	81
Number of laborers	3740

Expected production during 1948: 28,000 metric tons monthly. After dehydration, crude oil is immediately ready for export; there is, therefore, no refinery at Tarakan.

Balikpapan. After the Japanese capitulation, the refinery at Balikpapan was a total loss, as were also the oil fields and installations Louise and Sambodja, and the Tandjung fields were totally neglected. The pipe line Louise-Sambodja-Balikpapan was damaged.

*By the Netherlands Information Bureau, 10 Rockefeller Plaza, New York 20, New York, which is registered with the Foreign Agents Registration Section, Department of Justice, Washington, D. C., as an agent of the Royal Netherlands Government. A copy of this material has been filed with the Department of Justice, where the registration statement of the Netherlands Information Bureau is available for inspection. Registration under the Foreign Agents Registration Act does not indicate approval or disapproval of this material by the United States Government.

Production for Louise:

July, 1947	21,635 metric tons
September, 1947	29,230 metric tons

Production for Sambodja:

July, 1947	470 metric tons
September, 1947	1,690 metric tons

Production for Tandjung:

July, 1947	22 metric tons
September, 1947	29 metric tons

Total number of employes in Balikpapan area, 307; number of laborers, 13,512. Estimated monthly production for 1948: Louise, 30,000 metric tons; Sambodja, 5000 metric tons. Refinery capacity at present, 30,000 metric tons. Estimated capacity at end 1948: 100,000 metric tons, which is more than the prewar capacity.

Principal refinery products: Gasoline, kerosine, gas oil, fuel oil, diesel oil, and paraffine residue.

● **Sumatra.** The fields, plants, and refinery installations at Pangkalan Brandan are not yet approachable because they lie within Republican territory. Recently, extremists set fire to the Brandan plant.

At Pladju (Royal Dutch Shell) work was resumed October 1, 1946. The refinery and plants were totally neglected. Refinery capacity September, 1947: 130,000 metric tons; expected for December, 200,000 metric tons.

Products: Gasoline, kerosine, gas, oil. solar oil, diesel oil, fuel oil.

Field work at Pladju began in August, 1947. Expected production for December 1947: 105,000 metric tons. Expected production for December 1948: 280,000 metric tons.

Total Shell personnel: 287 employes, 9730 laborers.

The Djambi fields (central and northern Palembang) are not yet approachable.

Soengei Gerong (Standard Vacuum Oil) began repairs on its refinery in September, 1946. Production was begun in September, 1947. Daily capacity November, 1946: 3000 tons. Expected daily production January, 1949: 6000 tons. Since July, 1947, rehabilitation of oil fields and pipe lines was begun. In September, extremists set fire to five wells, but the fire was under control within three weeks. Meanwhile, small scale oil production was begun.

● **Ceram (Moluccas).** Installations were heavily damaged during the war. Rehabilitation has not yet started.

● **Java.** The Tjepu area is not yet approachable. Only the Lidah and Krukah fields near Surabaya can as yet be approached. The Lidah was stripped of its installations and equipment during the Republican administration.

Krukah resumed work in January, 1946. Now, 38 wells are producing 4400 tons of oil. There are 26 employes and 259 laborers.

The Wonokromo refinery was heavily damaged by Allied bombing in 1944. Two smaller installations were rebuilt at Wonokromo and nearby Bendul. The November capacity of 6000 tons will be maintained during 1948. There are 68 employes and 840 laborers.

Products: Asphalt, gasoline, gas oil. besides gas for Surabaya City.

● **New Guinea.** The New Guinea Petroleum Company (Shell, Standard Vacuum, Standard, California, Texaco) resumed explorations. From Sorong, roads have been built to different fields. In September, there were working in this area: 240 employes and about 4400 laborers. ★★★

SCRAPER TRAP

THE handling of sour crudes by pipe line companies has presented many problems not the least of which is to provide safer working conditions for operating personnel.

It has been found that manifold pits and sumps exposed to sour crudes tend to hold the poisonous vapors given off by the crude unless ventilation can be provided.

Pictured here is one way to construct a scraper trap above ground thus assuring adequate air circulation to remove sulphurous vapors.

The short run of the 12-in. line from the discharge side of the pipe dead ends below the surface and two 10-in. risers connect it to the 12-in. section used to insert the scraper. The line is angled gently down to pipe ditch depth to provide a smooth path for the start of the scraper.

A 12-in. blind flange connection has been welded to the end of the section and can be opened by the removal of two bolts. In inserting the scraper it is only necessary to push it by hand past the two risers to assure its traveling when pump pressure is impressed. ★★★

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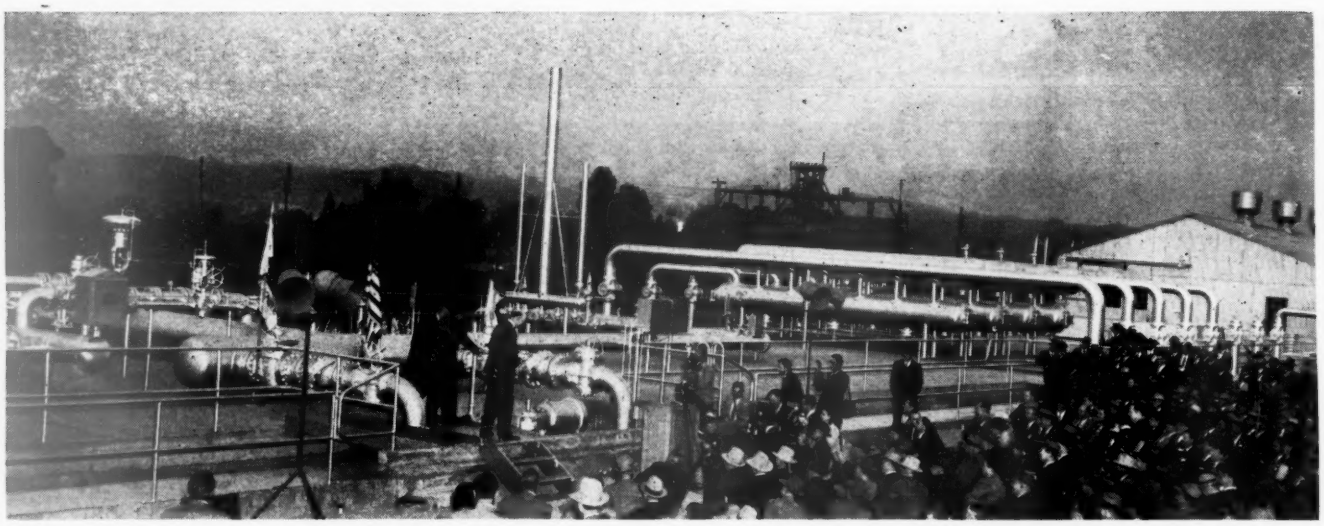

Ceremony opening valve to start flow of gas from Texas to California took place at Pacific Lighting Corporation's compressor plant, Santa Fe Springs, California. Lt.-Governor Knight turned the valve.

Texas-California pipe line completed

By RICHARD SNEDDON, *Pacific Coast Editor*

EVERYBODY who is anybody in the natural gas business, an imposing array of state and civic dignitaries, and a good representation of all the contractors, constructors, suppliers, and other implicated and involved agencies and individuals, foregathered at the compressor station of the Pacific Lighting Corporation at Santa Fe Springs, California, to witness a dedication ceremony celebrating the completion of the major portion of the Texas-California pipe line.

EXCLUSIVE

The occasion was one well worthy of celebration, for when in full operation this link between California and Texas is going to be of great importance to the future comfort and prosperity of the 4½ million citizens of Southern California. When the last 250 miles, from Eunice, New Mexico, to Dumas, Texas, is laid, the project will constitute one of the most difficult undertakings in the history of pipe line construction. It will be surpassed in length only by the 24-in. Big Inch and the 20-in. Little Big Inch, installed during the war to transport oil and petroleum products from Texas and Louisiana to the Eastern seaboard. The 30-in. section from Blythe to Santa Fe Springs is the largest diameter high test pipe ever fabricated and laid, and the complete line is the first major pipe line of any kind to enter California from out of state.

Officiating at the microphone during the preliminary part of the dedication ceremony was F. S. Wade, president of Southern California Gas Company, who first expounded briefly on the overall

STATISTICAL HIGHLIGHTS

Total length of pipe: Now complete from Eunice, New Mexico, to Santa Fe Springs, California	950 miles
To be installed between Eunice, New Mexico, and Dumas, Texas	250 miles
Total length of pipe line when complete	1200 miles
Size of pipe: Dumas, Texas, to Eunice, New Mexico	24 in.
Eunice, New Mexico, to Blythe, California	26 in.
Blythe, California, to Santa Fe Springs, California	30 in.
Total cost of project:	
El Paso Natural Gas Company section from Dumas to Blythe	$54,000,000
Southern California and Southern Counties section from Blythe to Santa Fe Springs	$16,000,000
	$70,000,000
Delivery capacity: Initial	175,000,000 cu ft daily
End of 1948	305,000,000 cu ft daily
Length of contract	30 years
Maximum operating pressure	807 psi
River crossings: Understream	5
Truss type	1
Suspension type	4
	10
Longest bridge: Canadian River crossing	1200 ft between towers
Energy equivalent of gas daily deliveries: 51,000 bbl of oil — 189 carloads coal	6 Hoover Dams
Speed of flow: 80 hours from Texas to Santa Fe Springs	
Pumping stations: El Paso Company	6 field and 6 booster
	Aggregate horsepower, 136,800
California	1 at Blythe
	Aggregate horsepower, 11,200
214-mile California section of line represents largest diameter high test pipe ever fabricated and installed.	
Pressure at Santa Fe Springs	250 psi
Comparison with other pipe lines:	
Big Inch—24 in. in diameter from Longview, Texas, to Phoenixville, Pennsylvania	1362 miles
Little Big Inch—20 in. in diameter from Beaumont-Houston area to Linden, New Jersey	1475 miles

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Left to right: A. F. Bridge, president, Southern Counties Gas Company; Lt.-Governor Goodwin J. Knight of California; Le Roy M. Edwards, vice president, Pacific Lighting Corporation; F. S. Wade, president, Southern California Gas Company; Paul Kayser, president, El Paso Natural Gas Company.

importance of the big line, and, incidentally, displayed a very effective microphone presence. Having said his say, Wade then called upon Arthur F. Bridge, president of Southern Counties Gas Company. The latter paid tribute to the suppliers of materials and contractors, who together, under distinctly difficult conditions were largely responsible for the carrying out of a rigid construction schedule that brought Texas gas to the Los Angeles area just in time for the peak winter load. Among those specifically named by this speaker were General Steel Mills, where steel plate for the pipe was rolled; Consolidated Steel Corporation, where the pipe was fabricated, and H. C. Price Company, constructors of the California section.

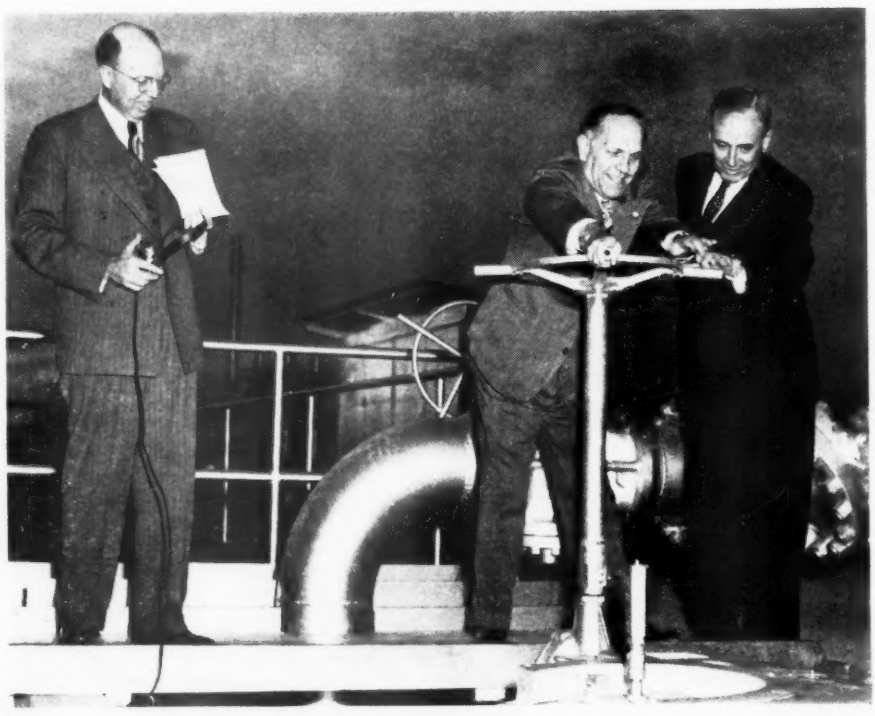
Bridge was followed to the platform by Paul Kayser, president of El Paso Natural Gas Company, which built the portion of the line between the Permian Basin fields and Blythe, California. He indicated that the completion of the gas line was a symbol of a new bond between Texas and California that he hoped would grow and strengthen in the coming years. He further paid high tribute to the men on the line—the 'dozer operators, the welders, the crane operators, and all the rest who kicked through in a magnificent way to finish a really man sized job. In introducing, the next speaker, Ira Rowell, member of the California Public Utilities Commission, Wade expressed the gratitude of all concerned to the Commission for its support of the project.

Also introduced were C. O. G. Miller and LeRoy M. Edwards of Pacific Lighting Corporation. It was pointed out that Miller had been actively engaged in the gas industry for approximately 58 years. Others to whom special tribute was paid in one way or another were Alden Roach, president of Consolidated Steel Corporation; Hal Price, H. C. Price Company; Paul Clark, president Clark Bros. Co., Inc.; R. A. Wehe, Public Utilities Commission, and Gordon Le Febvre, president, Cooper-Bessemer Corporation.

The actual swinging of the valve that opened the line and turned the first rush of Texas gas into California mains was contrived by Lieutenant Governor Goodwin Knight.

Approximately 300 people attended the function and were later entertained at a buffet luncheon served in a big tent erected right on the grounds of the Pacific Lighting Corporation compressor plant. An interesting fact relative to this portion of the program was that much of the food, and it was excellent, was cooked with gas that had just arrived from Texas, via the new line. ★★★

At the ceremonies were: David Gamble, Southern California; H. C. Price, contractor, and William Pipkin, Southern California, shown at right. Below, Lt.-Governor Knight, center, turns valve while Wade and Bridge look on.



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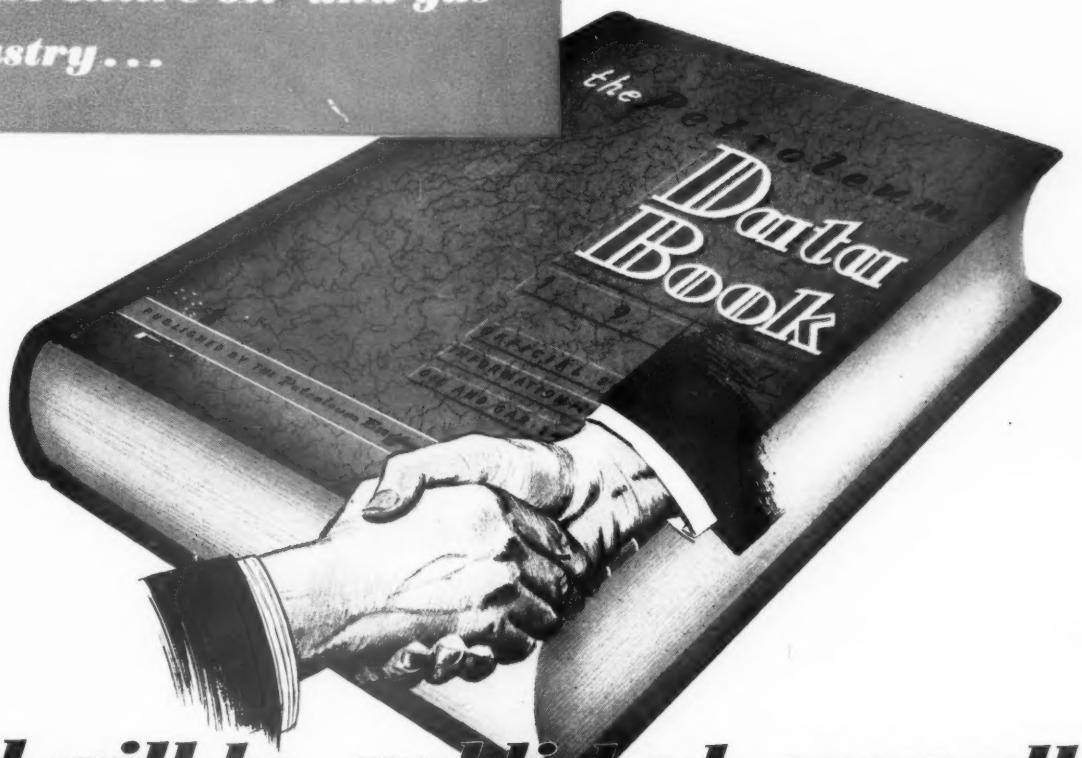

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Cycling at high pressure vs. depletion and cycling at low pressure*

By E. O. BENNETT, Petroleum Consultants

THERE has always been a question in the minds of producers and operators whether to operate an oil field or a condensate recovery project under pressure maintenance at its initial pressure or to produce the field to partial depletion and then commence an injection program.

Cycling, as used by the industry, is a rather broad term and applies to both oil fields and gas condensate type fields. The condensate recovery from single phase reservoirs and the return of denuded gas is ordinarily termed cycling. The production of oil and the return of included and accompanying gas is ordinarily termed pressure maintenance. In principle, the operations are the same, as reservoir fluids are produced, part of which are taken out, part burned as fuel, and the remainder returned to maintain reservoir pressure.

Before undertaking a discussion of when to start gas return, especially in condensate recovery operations, it appears advisable to enumerate the controlling factors involved in a field problem, whether it be in connection with gas return for pressure maintenance purposes in an oil producing property, or for the prevention of pressure decline in connection with a cycling project, for the recovery of hydrocarbon condensate.

The predominating consideration that controls is the one that will permit the greatest return to be made with the least capital invested, when operating under permissible rules of existing regulatory bodies or statutes.

It may be, and often is, possible to increase the ultimate recovery in barrels without regard to the cost of obtaining such recovery. Any such method is not one that will comply with the above condition and should not be adopted.

One problem that always bothers the producer or operator is that the price received for products has much to do with the method used for their recovery. A method of operation, or production, that will return the greatest earning with oil or condensate at one price may not do so at a different price. All present here have seen the price of oil vary from $0.10 to $3.50 per bbl, which is quite a range.

Although we do not anticipate any such variation of price range in the future, it can be readily seen that the best method of operating any pool or field would be to design for conditions at hand with as wide a range of flexibility as possible.

Methods of operation that always come up for discussion in a new development are pressure maintenance and cycling, by the return of produced, or produced and extraneous, gas to the reservoir from which liquid hydrocarbons are recovered.

Pressure maintenance should at no time be looked upon as a "cure-all" for many of our producing ailments, and should only be considered where the profit made by its use is greater than can be realized by other methods of operation.

The general reasons for adoption of pressure maintenance operations are now well understood by the producing industry generally. Such operations are important to the natural gasoline phase of production, and since you gentlemen are primarily engaged in this part of the oil business, I will briefly enumerate them once more as they are also important in cycling operations:

1. To retain sufficient energy in the reservoir to move oil to a well bore, from where it may be moved to the surface.

2. To maintain pressure to prevent gas originally dissolved in the oil from escaping, thereby increasing the viscosity of the oil and necessitating more energy to move a unit quantity through the reservoir.

3. To prevent edge or bottom water encroachment from moving the oil volume upward into an otherwise oil-free gas cap, thereby reducing the amount of oil that may be recovered.

4. To permit oil to be produced at maximum rates, whereby the rate of return on capital invested will be increased and labor costs reduced.

5. To save a sometimes wasted supply of gas for subsequent use.

6. If pressure is not maintained oil left in a reservoir will be "tank" oil. If pressure is maintained oil left in the reservoir will have gas in solution and its tank oil content will be much less than that left by pressure decline production. Due to this fact alone, millions of barrels will be produced from large reservoirs by pressure maintenance that otherwise would be lost. This will also be the effect in an oil ring in connection with condensate recovery from a gas cap with oil at its flank edge.

Next it should be pointed out that there are two types of subsurface reservoirs containing condensible hydrocarbons in the vapor phase. They are:

1. A single phase gas reservoir where all liquefied hydrocarbons are in the vapor state and no oil ring or column is present.

2. A gas cap reservoir containing a supply of gas and liquefiable hydrocarbons in a vapor state where such gas cap exists in connection with an oil ring or column.

Either or both of the above types of reservoirs may be and generally are accompanied by bottom or edge water or both.

● **Type of field should be determined.** As soon after discovery as possible, the size and nature of a new pool should be determined, in order to evaluate the gas and oil volumetrically to ascertain their relative values and the method of operation for maximum ultimate economic recovery on capital invested.

● **Two-phase reservoir.** If a two-phase reservoir is discovered, it is obvious that any method that will increase the recovery of liquefied hydrocarbons from the gas cap, by causing a loss in recovery from the liquid phase, is wasteful and should not be conducted. Pressure decline methods of operation prior to cycling can and will cause serious losses where sizeable oil volumes exist. This means that in a field or pool where such conditions exist in connection with a gas cap condensate section pressure maintenance operations under high pressure cycling are mandatory, and until such time that the economic limit of oil production is reached there is no choice in the matter of operation.

This then brings our subject down to a single-phase reservoir.

● **Single-phase reservoir.** Recently the methods of operating a single-phase condensate pool have received much attention in an attempt to determine how to obtain the greatest economic yield.

In order properly to discuss this subject it is assumed that there is a market demand for all available gas and it needs not to be returned to the producing formation to save the gas itself. This is especially true in your part of the country where we are sending you a lot of Btu's through the "Biggest Inch" line from our supply back in Texas.

● **Laboratory work.** A very interesting, valuable, and enlightening discussion and analysis of the best method of operating a single-phase reservoir was undertaken here on the coast by Standing, Linbad, and Parsons, and presented before the AIME earlier this year.

Conclusions reached from this excellent laboratory study were: "The recovery of the heavier components from a gas cap or retrograde pool under various production methods has been calculated. The results show that the recovery is greatest if the reservoir pressure is allowed to decline prior to cycling dry gas".[1]

I shall try to bring out the essential factors that may influence the determination of which way to operate a condensate field. The following discussions are assumed in connection with single-

*Presented before California Natural Gasoline Association, Los Angeles, October 10, 1947.

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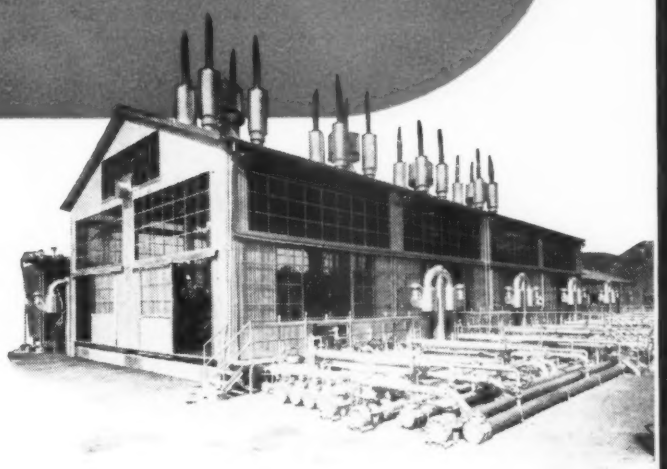

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phase reservoirs only, although there are but few of this type discovered in condensate operations.

It also will be assumed that the proper type of unitization will be carried out as no condensate recovery project can be conducted properly in the absence of unitization. Concerning unitization, it is extremely difficult to understand the reluctance to unitization shown by some operators, and I believe you have your share of such trouble out here. No case is yet known where all participants have not benefited by unitized operations. This will also apply to two-phase reservoirs and no valid objections to unitization can be proposed, although many excuses are offered in each one that comes along. With a proper spirit of "give and take" and fairness among and between operators there is no reason unitization cannot be made to work any place and under any conditions. Results from unit operations speak for themselves.

If a pool is to produce by pressure decline methods, liquids will condense out of the vapor when the critical pressure is reached. Such liquid will remain in the formation unless again vaporized and carried out by recycled dry gas. The reservoir temperature is assumed to remain constant under pressure decline operations.

Under pressure decline operation only a minimum number of producing wells are required as no consideration of sweep pattern efficiency is involved. All gas will find its way to the wells used because of pressure differentials created. The laboratory work leading to the conclusion above stated indicates that the greatest recovery will be obtained by cycling the gas at low pressure three times. It is not believed that sufficient correlation exists between laboratory work and field practice to apply such conclusion directly. Some of the disturbing factors are pointed out below.

If the pressure in a reservoir was originally 4000 psia, as indicated for maximum recovery before cycling, approximately 90 per cent of the original gas would have been produced, assuming no water drive exists and that the gas follows Boyle's Law. Neither of which is quite true but will suffice for this discussion.

The number of wells required or permitted may be limited by the rules and regulations of regulatory commissions, or by physical capacity of a well to produce.

The number of wells required to produce a volume under the above conditions will be much smaller than the number required to effect an efficient sweep pattern at the lower pressures. For an efficient sweep pattern a large number of wells would have to be drilled. To reduce the pressure, as above cited, in a large reservoir might require 10, 15, or 20 years. The drilling of many new wells in a field at this time, with only 10 per cent of the original gas in place in order to effect an efficient gas sweep, would hardly meet with management's approval, especially where the cost could run into a million or more dollars. If a field was produced under pressure decline and management would not then drill the wells required, the field so operated would show much less recovery than one where cycling was involved at high pressure.

The experiments showed that for the test conditions 100 per cent of the residual condensate could be vaporized after the gas had passed through the sand three times at pressures well below the retrograde point. Under actual field conditions it would be necessary to pass more than three volumes through the sand because of irregular advances through the sand body, and because of the nature of the sweep pattern.[2] It must be remembered that 100 per cent vaporization also can be effected by cycling the stripped gas at pressures above the retrograde point at fewer than three volumes. In either the retrograde or normal region of pressures, recycling of stripped gas would cease when the produced gas became so lean that it could not profitably be produced and reinjected. In high pressure operations as now actually practiced, cycling continues until the economic limit of recovery is reached. In practice the relative efficiency in recovery of liquefiable products in the gas would depend upon the relative costs per M cu ft and other economic and practical considerations.

Economic and practical conditions vary quite widely in gas condensate reservoirs, particularly with respect to the market for residual gas. Where there is no satisfactory market for the residue gas, economics usually will cause cycling at original pressures until a market can be developed. When there is a satisfactory market for the residue, the deferment from the sale of residue gas must be balanced against higher and quicker recovery of condensate and the possible appreciation in gas prices while it is being withheld from the market. From the profit standpoint it is usually not profitable to build and operate a cycling plant when a satisfactory residue market exists, except for rich gas of at least 50 bbl per 1,000,000 cu ft. Many gas reserves have oil rings that may be the compelling reason for withholding from an available market until the recoverable oil has been produced. Under such conditions it is likely to be profitable to cycle the gas cap to obtain income from the gas liquid contents while recovering the oil. If such a pool is not unitized, the matter of correlative rights can offer serious handicaps to both the oil and gas cap operator.

From the standpoint of pure conservation, cycling is not justified except on the richer gases. The savings in liquid products must offset the greater field consumption of gas in a cycling plant and the break-even point has been found to be at about 50 bbl of liquid recovery per 1,000,000 cu ft of gas. The loss of gas for fuel becomes a more predominant factor for cycling at lower pressures. Practically, conservation cannot be separated from economics as conservation cannot be enforced where it creates an undue economic loss to property owners.

The total recovery by pressure maintenance or cycling at high pressure and that which may be recovered by pressure decline from initial pressure to a low pressure and then using a gas sweep should recognize all factors to make a proper comparison.

It is believed that the comparison should be by comparing the total liquids recoverable down to abandonment of the project in each case. In the high pressure cycling, part of the liquids will be recovered while the pressure is maintained and an additional quantity will be obtained during the period that the field is having its pressure depleted by the sale of the residual gas (after cycling at high pressure) down to the abandonment pressure. The volume of liquid that will remain after the high pressure cycling was shown by the experiments to be 29 per cent, 58 per cent of which would be recoverable during the depletion by sale of gas. The sum of the two values is 87.83 per cent, which is greater than the 87 per cent shown by the experiments for early pressure depletion and gas sweep.

The amount of liquid recovery that will actually be obtained from the time cycling is stopped under the high pressure program down to project abandonment period will be governed to a large extent by the content of the gas and the type of plant doing the processing. When the cost of processing is greater than the recovery value the extraction will cease in both methods of operation.

With credit to the high pressure operation of the economically recoverable quantity of liquids to abandonment for comparison of the total quantity of liquids economically recoverable by the decline and sweep method there appears to be no choice. When drilling costs and time factors are applied it then appears that the high pressure operation shows far greater recovery and is the system that should be used.

It is appreciated that a single specific example is not sufficiently broad in its application to justify any final conclusion, as the type of reservoir material can and does vary over extreme ranges between fields, and this fact alone will make some difference in conclusions reached.

Conservation and correlative rights do not always go together and some interpretations of conservation can cause confiscation. The following examples are given to show the practicality of cycling at high pressure versus depletion and cycling at low pressure.

A reservoir is assumed that contains 100,000,000,000 cu ft of gas at 3000 psia pressure and has five wells averaging 30,000,000 cu ft daily potential. One well is to be used as an injection well and four are to be used as producers. The sweep pattern efficiency is assumed 80 per cent of the wet gas volume.

If cycling were applied to such a field, under original pressure conditions the average producing pressure during the cycling period would be about 2750 psia, and the average potential 26,000,000 cu ft. Assuming permissible produc-

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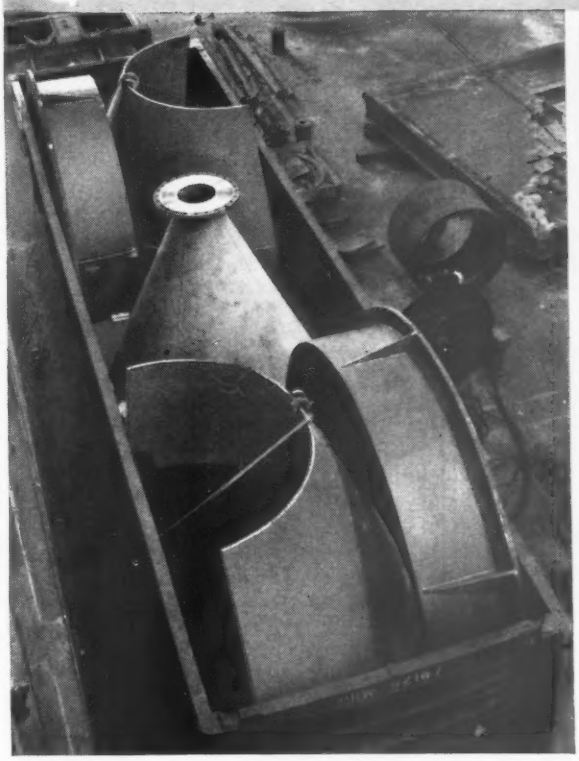

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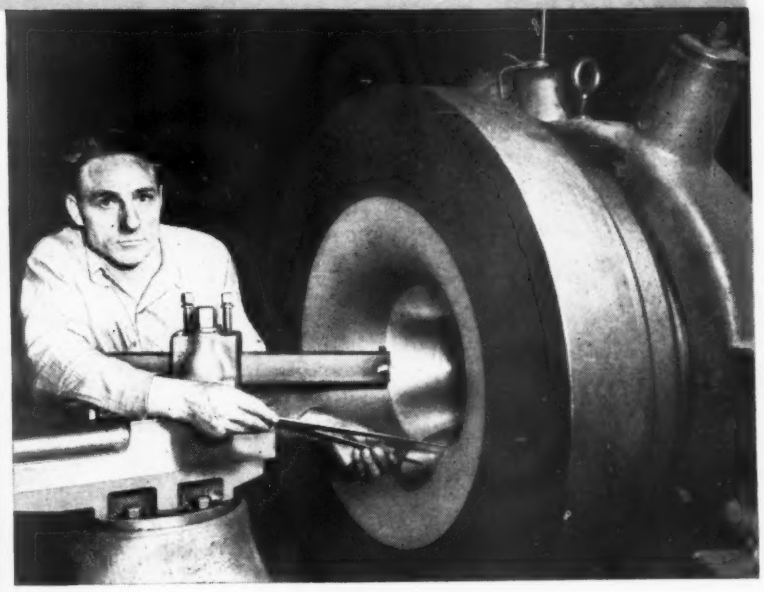

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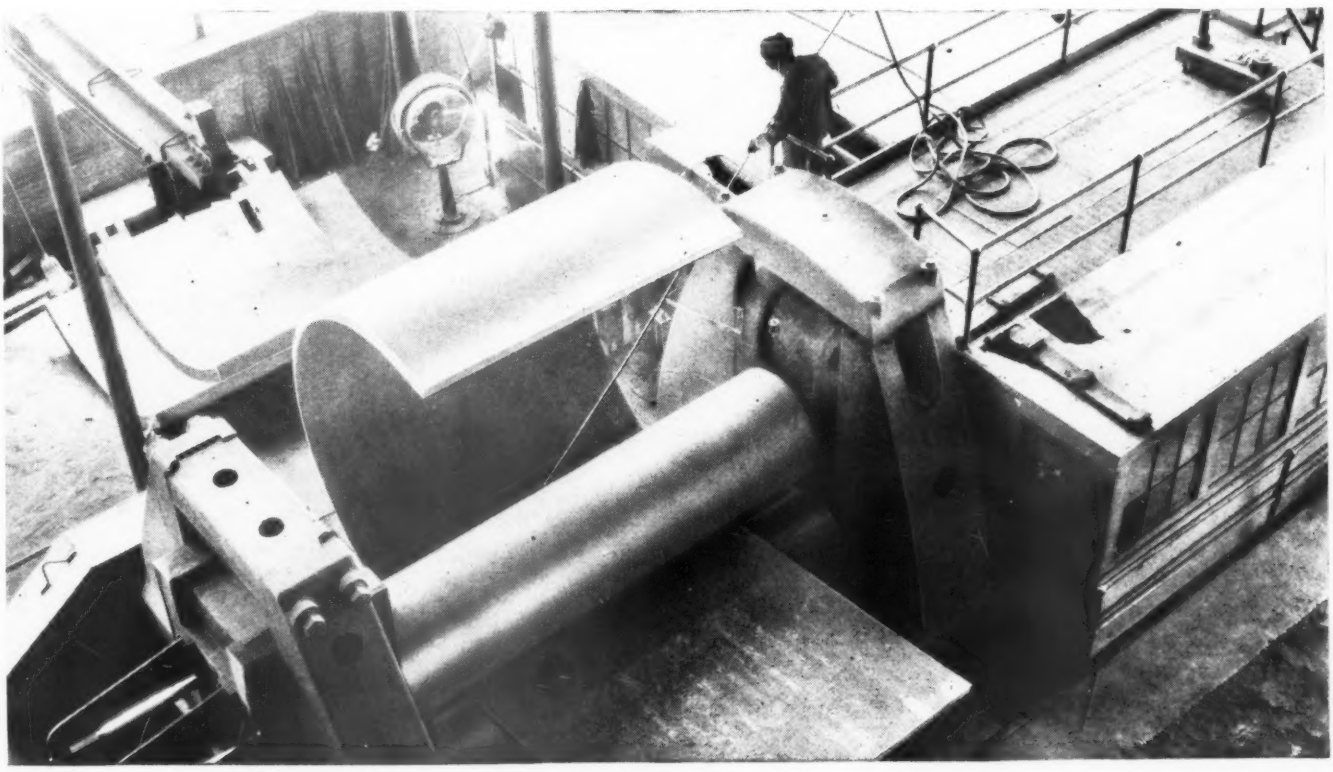

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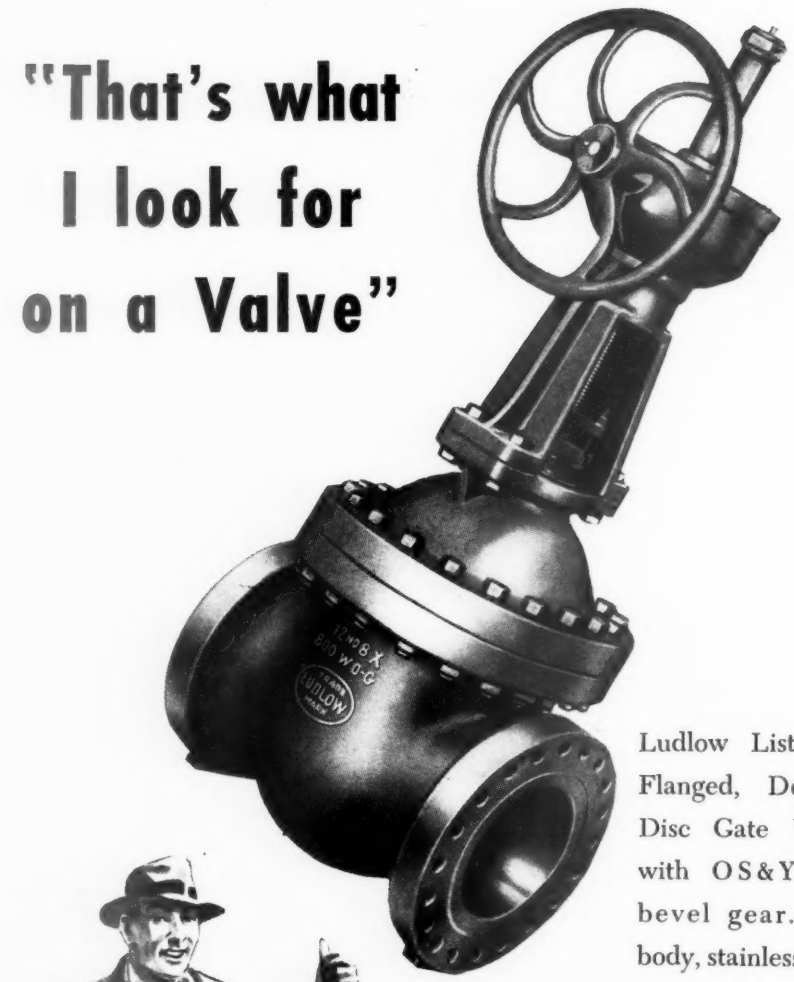

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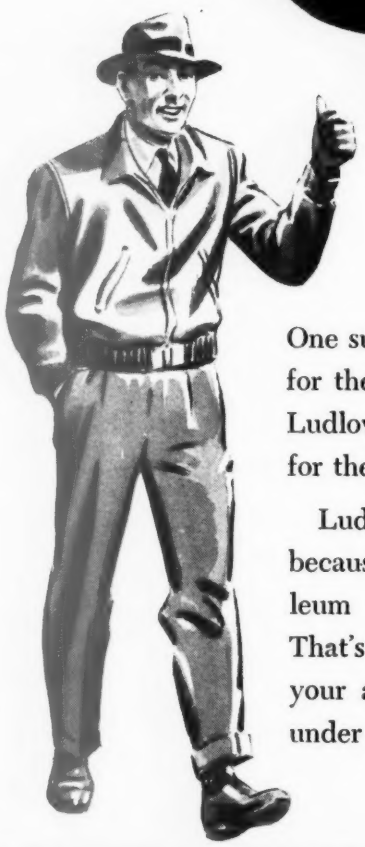

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tion of 20 per cent of the potential, the production per well would be 5,200,000 cu ft and the field production 20,800,000 cu ft daily. Allowing for a total dilution of the wet gas by dry gas in the amount of 20 per cent, the reservoir would be cycled out in 13 years, after which gas sales would begin and be carried out continuously until the abandonment of the reservoir. During this production most of the remaining wet gas would be processed.

Next, assume the same reservoir had been depleted so that the pressure had dropped to 1000 psia before cycling was begun. The gas reserve would then be 33,300,000,000 cu ft. During cycling starting at this pressure the average producing pressure would be about 800 psia and the average potential 3,200,000 cu ft. Of this potential, 20 per cent will be 640,000 cu ft per well or 2,540,000 cu ft for the field. At 80 per cent producing efficiency in sweep pattern it would take 28½ years to pass one volume of gas through the reservoir sand and 85½ years to pass the gas through three times. Allowing for irregularities in the sand body, it would take even more time.

Now, assuming the pressure be permitted to drop to 500 psia before cycling is begun, the reserves in the reservoir would then be about 16,700,000,000 cu ft and the average production pressure about 350 psia. The well potentials would be about 1,100,000 cu ft and at 20 per cent of this capacity the well production would be 220,000 cu ft and for the field 880,000 cu ft. It would take 41½ years to pass the gas through once and 124½ years to pass it through three times, assuming field efficiency equal to laboratory efficiency.

From the above it can be seen that if the decline method down to 400 or 500 psia were used and then cycling begun, many more wells would be required to produce the field out in the same time as could be done under high pressure cycling. The first case presented above would require 85/13 or 6½ times as many producing wells as originally existed, or 22 new wells. If the field was 10,000 ft deep the wells would cost $100,000 each or more, and a new investment of $2,200,000 would be required. If the liquid content initially averaged 60 bbl per 1,000,000 cu ft and, as the laboratory experiments indicated, 16 per cent more liquid recovery could be realized by the decline and sweep method, then the reservoir we have assumed would contain 6,000,000 bbl of recoverable liquids and the gain of 16 per cent would have been 960,000 bbl. At an assumed price of $2.15 per bbl, or a net price of $1.95, the gain would be worth $1,870,000 and its cost $2,200,000, indicating that the operation would not be justified.

If the additional wells were not drilled the time required to earn the income from the 16 per cent increased recovery would be more than offset by the discount factors that must be applied against the deferred income.

If we go to the 500 psia pressure it can be seen at a glance that the number

of wells required to deplete the field under any reasonable period of time becomes prohibitive and cannot be considered at all because of the state of depletion of the reservoir.

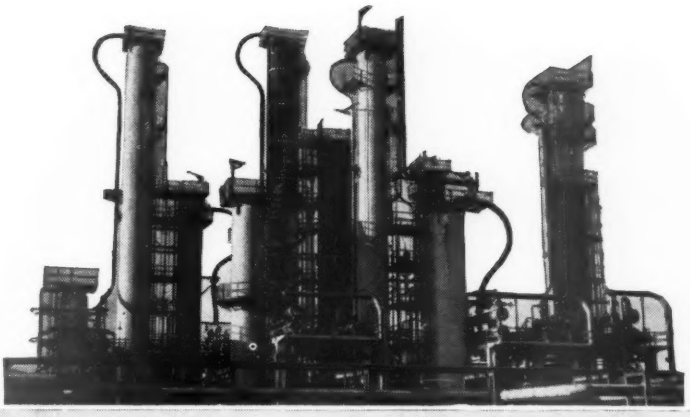
From these cases it readily can be seen that high pressure cycling without depletion and gas sweep is more economical and that the increased recovery that might be made by decline in pressure and gas sweep methods will cost more than its market value, and is not in the realm of economical range of recovery.

To cycle at low pressures the cycling plant would be smaller and less costly, but the expense of producing, processing, and reinjecting the gas would be considerably more per M cu ft, hence it could not be produced to as low a content as under high pressure cycling. The gas content at 1000 psia would be much less than the original, and at 500 psia it would be nearly as rich as at the original conditions. At lower pressures it would become even richer, as has been shown by Lewis.[3] To start cycling then would be to prevent the gas from becoming richer, whereas cycling in the early stage of operations would prevent the gas from becoming leaner. The ultimate quantity of liquids will be theoretically increased, however, by low pressure cycling, but such theoretical increase cannot, in the light of present practice, be done except at a loss.

During the time the field pressure might be depleted under pressure decline methods, gas sales in all probability would take place and gasoline and pipe line facilities installed, markets established, and sales contracts made. When the lower pressure was reached the operator would be confronted with the alternative of taking his residue gas off the market, installing an injection plant and the drilling of more wells, or withholding his gas, not for 13 years in the case of high pressure injection but for many times the 13 years. It is not hard to visualize most operators deciding against cycling at this stage under such conditions, or, if they did go ahead, they could not be expected to operate cycling long enough to approach the completeness of revaporization indicated by the laboratory experiments and needed to increase the recovery.

The above examples of a field case assumed a sand body of moderate thickness and permeability. If instead of the potentials used the well potentials were three times as large, cycling at all three pressures discussed could be conducted in one-third of the time stated. In fields where wells have high permissible allowables the disadvantage of delayed cycling would not be so great as with smaller wells, but economic considerations would cause cycling to cease when the content of the gas became worth less than the operating expense, and there would still be the disinclination of the operator from severing his gas markets and current income.

As reservoirs that are initially under retrograde pressures are always deep,



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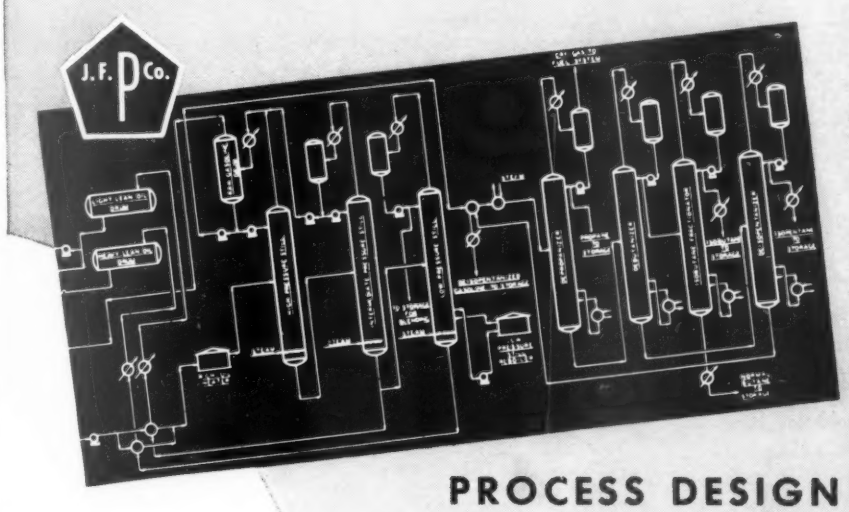

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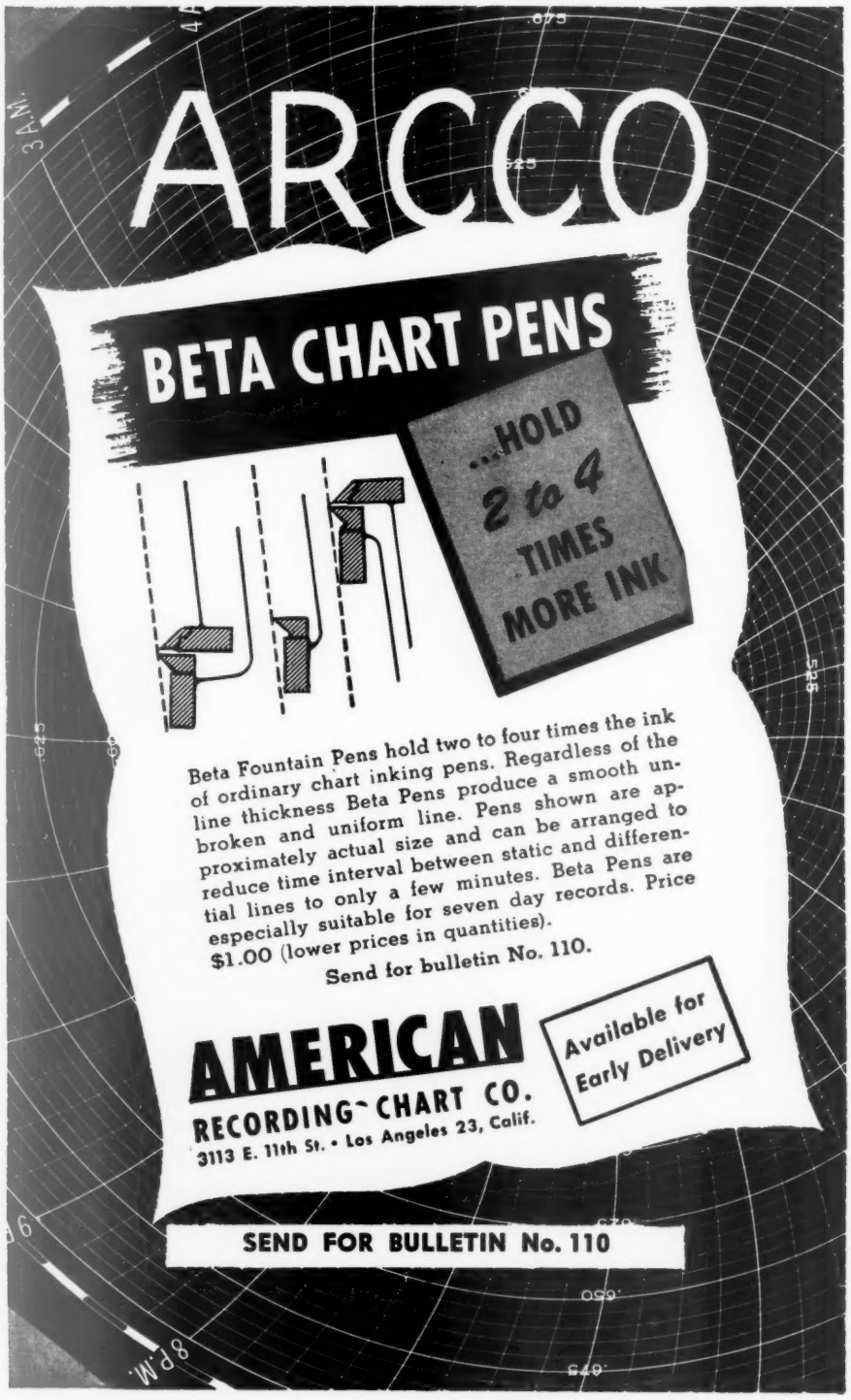
they cannot be produced to very low pressures profitably, except where the sands are very permeable and quite thick, and where the price of gas is high. In some deep fields the prospects are that it will become uneconomical to produce them much below 500 psia.

An intensive study of the effect of reservoir temperature on retrograde loss indicates that as the reservoir temperature increases there is a decrease in the loss resulting from retrograde condensation.[3] From this it may be anticipated that the retrograde losses from deep reservoirs will be less than for the shallower ones.

Under the above conditions, aside from the economical considerations previously discussed, the use of revaporative sweep along with pressure decline will become less effective with regard to total recovery as deeper development is encountered, and since all indications point to condensate recovery in many real deep pools, the pressure decline and gas sweep method appears to have but little value for future operations.

In the laboratory work where it was indicated that the pressure decline and gas sweep method of operation would show the highest recovery one important variable was not present. It was the permeability of the producing section, which has so much to do with the sweep pattern efficiency in a field operation.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● **Sweep pattern efficiency.** If wells are spaced properly and injection rates controlled it is possible to have a high sweep pattern efficiency under pressure maintenance or early cycling.

Permeability does not follow regular and stratified patterns and flow in an actual operation is not always lateral. Diagonal flow often exists. Many hundreds of core samples recently have been analyzed in a large new cycling program in North Louisiana and the permeability followed no regular pattern.

If lenticular islands exist in a large sand body, and tests indicate this to exist, it can be seen that so long as pressure is maintained above the retrograde point the gas in these "islands" can move to the producing wells. If, on the other hand, the pressure is reduced below the retrograde, the liquid condensing in the island area occupies a much larger percentage of the total hydrocarbon pore space than in the more permeable zones and an effective block to any material flow is caused, which will result in the bypassing of these "islands" during the gas sweep in the pressure depletion operation. This will reduce the recovery and it is not believed that the laboratory conditions can be reached or even closely approached.

● **Liquid content and depth.** Experience indicates that reservoirs less than 4000 ft deep show no important retrograde characteristics and that the capacity of wells to produce generally increase with depth. The liquid volume generally is greater in the deeper wells.

As the condensate wells go deeper the problem of operating them at 400 psia or less becomes very critical, and a safe limit for production operations alone will prevent getting down to the suggested pressures.

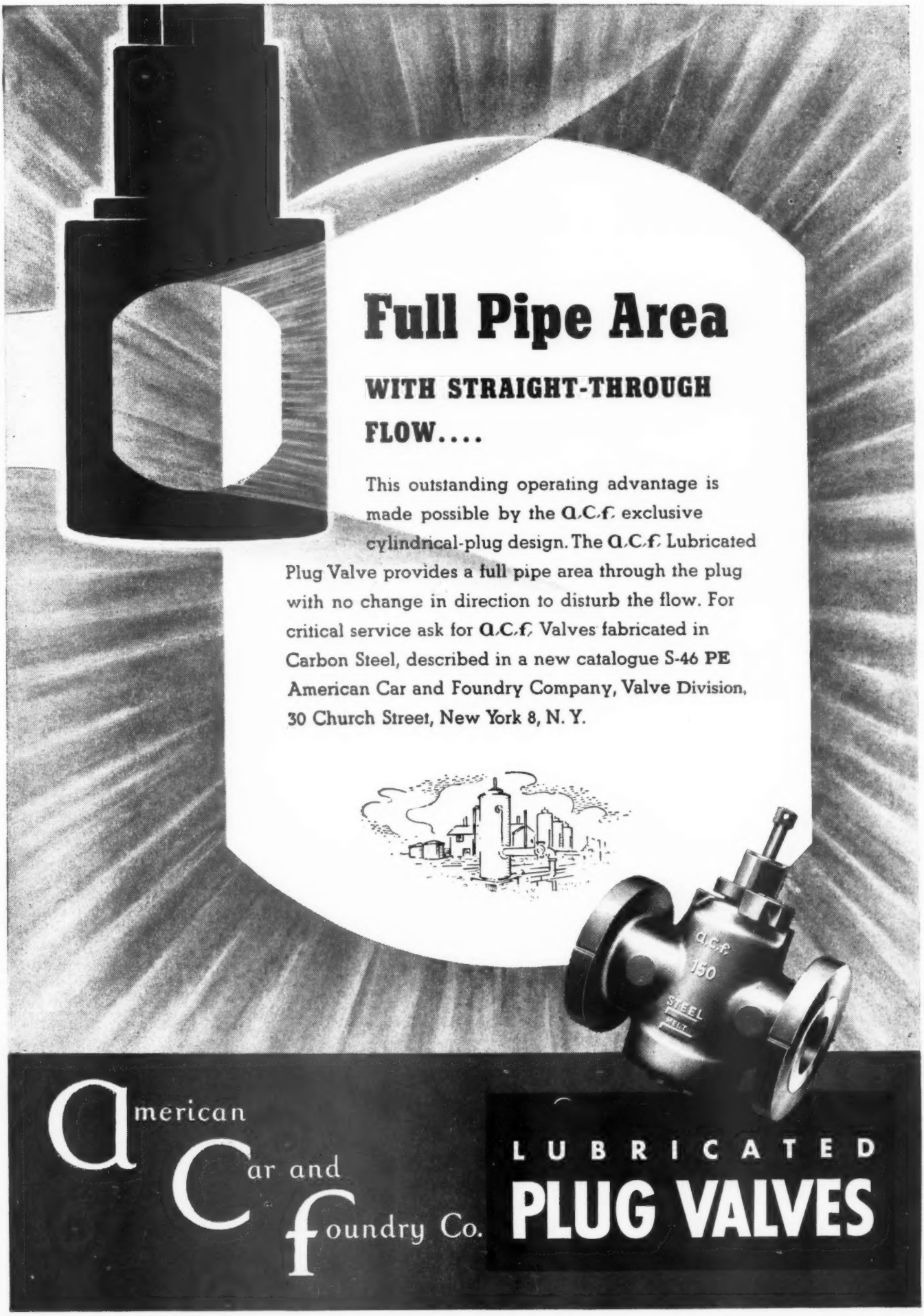
● **Content and composition.** As the capacity of a gas to carry liquid in vapor form depends upon the total composition and distribution of such composition, it can be seen that there can be wide variation of the content of condensible hydrocarbons in gas that exists at the same temperature and pressure.

Soviet output low

The British Petroleum Press service has asserted that Russian oil production has fallen "far short of its targets" in comparison with achievements elsewhere "of modern progressive private enterprise."

The article said the "impressive expansion" under Russia's first five-year plan was made possible only by the "most ruthless and wasteful exploitation" and with "irreparable damage to the fields."

The publication said there is no lack of zeal on the part of the workers; but there are "grave deficiencies in the organizational and administrative sphere."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Olds, Sage, and Lacy[4] have shown how the capacity to hold the less volatile hydrocarbons in the vapor phase can be reduced by removal of propanes and butanes from the gas.

Large differences in liquid content have been found in a single reservoir in the Stratton-Agua Dulce area of South Texas. Any appreciable change in this value cannot be shown in laboratory experiments.

● **Effect of pressure decline production on gasoline plant operation** A gasoline plant can only be installed when:

1. There is a sufficient volume of gas for processing that capital invested, plus a reasonable earning, can be made during the life of the project. More efficiency in recovery can be maintained with high pressure absorption. Under cycling and pressure maintenance the pressure will remain in a narrow band at a high level, and a high pressure plant may be installed. Under pressure decline procedure a plant to take care of excessive conditions will operate with lower efficiency during the latter life of the project.

The horsepower required for returning gas under high pressure cycling will be less than under pressure decline and low pressure cycling as larger volumes of dry low pressure gas will be required for the so called "evaporative sweep." The content of much of the gas under pressure decline and evaporative sweep will be too low for economical processing and because of the volume required and the time required, the labor costs may become prohibitive. The time required to deplete the life of a condensate field would be far in excess of that generally considered available for equipment in a gasoline recovery plant.

● **Conclusions.** 1. Laboratory experimental work, although theoretically correct for the equipment used, does not adequately correlate test equipment with full scale operations in a cycling program, and conclusions reached by such work must be considered with extreme caution before being applied to actual production practice. All factors must be given consideration before proper comparison can be made.

2. Theoretical differences in recovery of a high pressure cycling system versus pressure depletion and low pressure cycling do not show sufficient increase to offset the unknown and variable factors, to assure that pressure depletion and evaporation sweep will show any increased recovery. Where economics and time factors are used the reverse appears to be the result.

3. If suitable gas markets are available, a study should be made to determine whether or not the starting of a condensate recovery project will be economical where the reservoir gas contains under 50 bbl per 1,000,000 cu ft of gas.

4. In the absence of a gas market at a reasonable price, cycling may be used in a field where the barrels of recovery are less than 50 per 1,000,000 cu ft, in order to provide current income. Such an operation may not be the most economical if a market is later obtained but does permit current income prior to market availability.

5. A study of several existing cycling projects indicates that high pressure cycling is more economical than pressure depletion and gas sweep would have been for the same fields and based on information and experience available it is the author's opinion that the present system of condensate recovery in general use should be continued until more experimental data is available and the correlation of such data, when recognizing such factors, indicates changes should be made.

6. Conservation as generally understood in the oil industry is the elimination of physical waste, and as neither of the methods of operation discussed in this paper create waste, both will comply with all the conservation regulations generally in effect. Operations for conservation alone are not necessarily practical or economical, and when practical and economical considerations are applied to cycling operations it will be seen that high pressure cycling rather than depletion and evaporative sweep will predominate.

References.

1. Conclusions from paper by Standing, Linbad, and Parsons, published in *AIME Petroleum Technology*, May 10, 1947.
2. Rotterwich and Bennett, NGAA Annual Meeting 1946.
3. J. O. Lewis, *AIME*, February, 1946.
4. Olds, Sage, and Lacy, *AIME Transactions* 1945.

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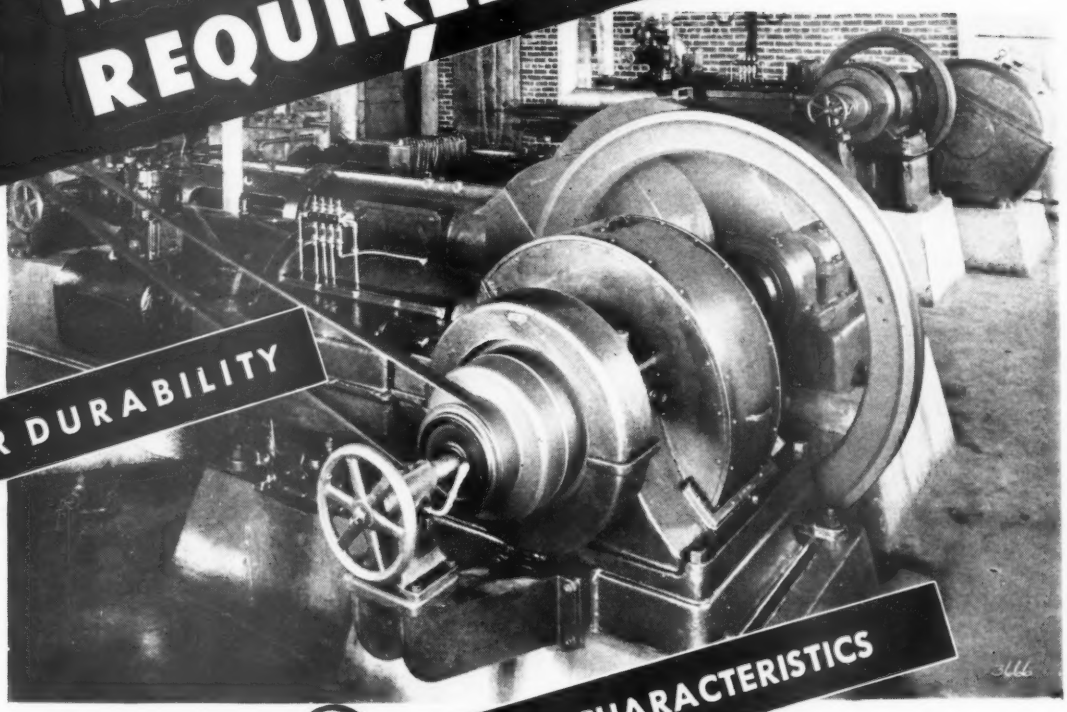

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Factors to be considered in the selection and use of subsurface sucker-rod pumps*

By R. L. CHENAULT†

THE general principles of sucker-rod pumps as used in oil wells are well known. For this reason it is proposed to describe the general types of pumps rather briefly and then point out a few characteristics of various types of pumps to indicate factors to be considered in selecting the most suitable type of pump for any particular well conditions.

The bores of reciprocating oil well pumps commonly range from 1 in. diam to 4¾ in diam. The 4¾-in. bore pump has a displacement about 22½ times that of the 1-in. pump for a given speed and stroke length. This wide range of pump capacities is necessary to permit the selection of the most efficient and economical pumping equipment for all conditions encountered. It is pointed out that in many wells it is necessary to pump large volumes of water along with the oil so that the pump has to have a capacity several times that indicated by the net oil production.

The following bores of subsurface pumps are now standardized by the American Petroleum Institute: 1 in., 1 1/16 in., 1¼ in., 1½ in., 1¾ in., 2 in., 2¼ in., 2½ in., 2¾ in., 3¾ in., and 4¾ in. Stroke lengths range from a few inches to more than 20 ft. and production rates with this type of pump range from a fraction of a barrel per day—with part time operation—to approximately 3000 bbl per day.

There are two broad classifications of pumps operated by sucker rods. The older type is now known as a "tubing pump." This term indicates that the pump barrel is attached directly to the tubing of a pumping well and lowered to the bottom of the well, or to any desired location for pumping, as the tubing is run into the well. The plunger, or traveling valve, of a tubing pump is run in on the lower end of the sucker rods until it contacts the lower valve, or "standing valve" assembly. The rods are then raised sufficiently to prevent bumping bottom at the end of the down-stroke and connected to a pumping unit, or jack, at the surface. Typical tubing pump assemblies are shown in Fig. 1, "A" and "B."

A more recent development is the "insert" or "rod" pump in which the entire assembly of barrel, traveling valve or plunger, and standing valve, is installed with the sucker rods and seated in a special seating nipple, a tubing pump barrel, or other device designed for the purpose. The rod type pump has the obvious advantage that the entire pump may be removed from the well for repair or replacement, with only a rod pulling job; whereas, with a tubing pump it is necessary to pull both rods and tubing to remove the pump barrel. The rod pump, however, is necessarily of smaller maximum capacity for a given tubing size.

Fig. 1 "A" shows a cold drawn working barrel with upper and lower couplings, and a standing valve assembly that may be pulled with the sucker rods, if desired. The traveling valve consists of a simple 4-cup assembly. Similar traveling valves are commonly equipped with from 4 to 12 cups, and larger numbers are sometimes used.

Fig. 1 "B" illustrates a tubing pump equipped with a metallic plunger, an extension nipple, and an oversize standing valve. This assembly also is equipped with a closed cage, and ball and seat below the plunger. A closed cage valve attached to the bottom of the plunger is often referred to as a "gas valve" inasmuch as the clearance space is reduced with a valve at this point and the pump will handle gas with less danger of gas lock.

It is desirable to permit a metallic plunger to stroke out both ends of the barrel a short distance to distribute wear over the entire length of the barrel. This permits the use of an oversize plunger in many cases, to compensate for barrel wear, and to reduce slippage, without the necessity for refinishing the barrel. The lower extension nipple shown in Fig. 1 "B" permits the plunger to stroke out the bottom of the barrel the desired amount without striking the standing valve.

Fig. 1 "C" shows a stationary barrel, top-seating "insert" or "rod" type pump equipped with cups and composition rings. A stationary barrel pump may be designed for top seating, as shown, or for bottom seating. Top seating is preferred wherever it is possible to use it, as this arrangement provides a seal just below the oil discharge from the pump to the tubing and prevents sand or other solid material from settling between the barrel and the tubing, thereby minimizing the chances of the pump becoming sanded in place so it cannot be pulled with the rods.

Bottom seating is necessary if the rod pump is to be seated in a tubing pump barrel that still has the lower coupling in place, if the length of the rod pump barrel is greater than that of the barrel used for seating. With bottom seating the pump barrel extends upward into the tubing and there is no circulation of well fluid around the outside of the barrel. For this reason, the pump is more likely to become sanded in place, and top seating is recommended wherever it can be used.

The stationary barrel pump shown in Fig. 1 "C" is fitted with a "sand check," which consists of a drop valve mounted in the cage of the valve rod guide and loosely fitted around the valve rod. This drop rises on both the up-stroke and the down-stroke of the plunger, or traveling valve, to permit the discharge of well fluid. If the pump is shut down, however, the drop rests on its seat and prevents suspended sand that settles to the bottom of the tubing from entering the pump barrel where it may cause the pump to jam when it is again started. A "sand check" is important in a pump of this type when used in wells producing appreciable quantities of sand. There is an unavoidable restriction above the pump barrel to provide for the seating device and the valve rod, and any considerable quantity of sand would be extremely difficult to force through this restriction. It is pointed out that one-tenth of one per cent by volume of suspended sand in a 4000-ft well will result in a solid sand pack 4 ft in length in the tubing if all the sand settles to bottom, or a much greater length pack if it is permitted to settle into the pump barrel, which necessarily is much smaller than the tubing. A sand pack of this type usually is dislodged from the tubing without difficulty by pumping fluid through it for a period of time, but if it is permitted to settle into the pump barrel it has to be removed on the first stroke, if at all, and the pump is very likely to jam.

Fig. 1 "D" shows a traveling barrel type of rod pump fitted with a metallic plunger. This type of pump is necessarily bottom seating but it is not as susceptible to sanding in place as is the stationary barrel pump with bottom seating because there is a continual surging of well fluid in and out of the lower end of the barrel while in operation, and sand cannot settle into the barrel when shut down. Sand may settle below the barrel and prevent full travel on the down stroke, however.

†Research and development engineer, Oil Well Supply Company, Oil City, Pennsylvania, subsidiary of U. S. Steel Corporation.

*Presented before The American Society of Mechanical Engineers, Houston, Texas, October 5-8, 1947.

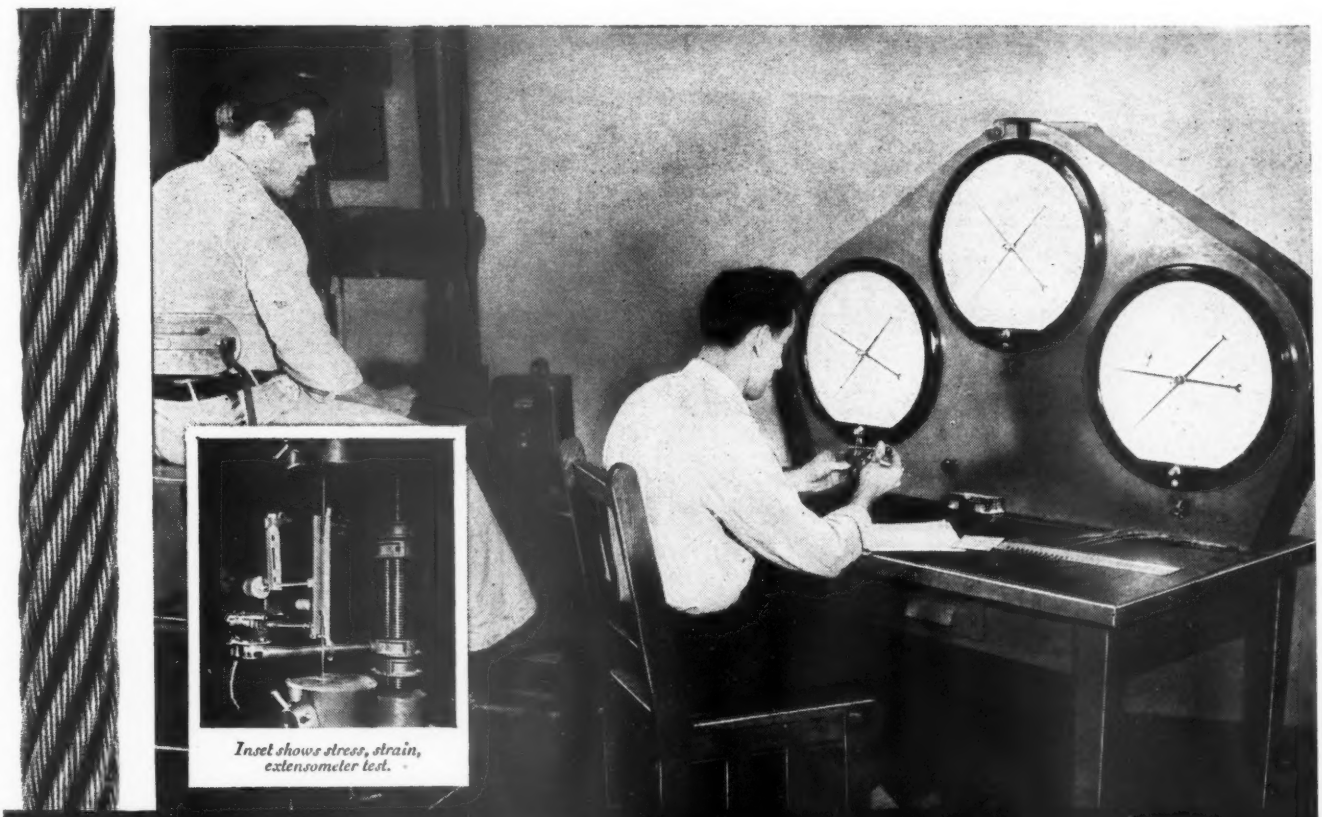

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FIG. 1. Typical pump assemblies.

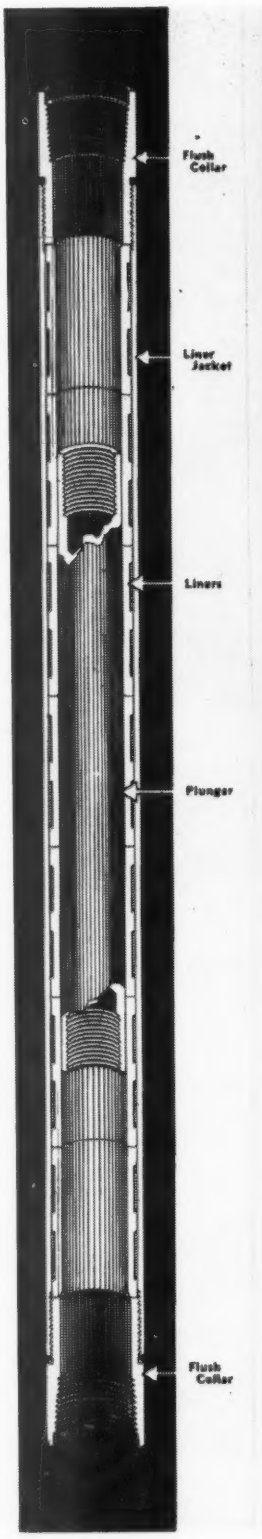

FIG. 2. Sectional liner tubing pump barrel with plunger.

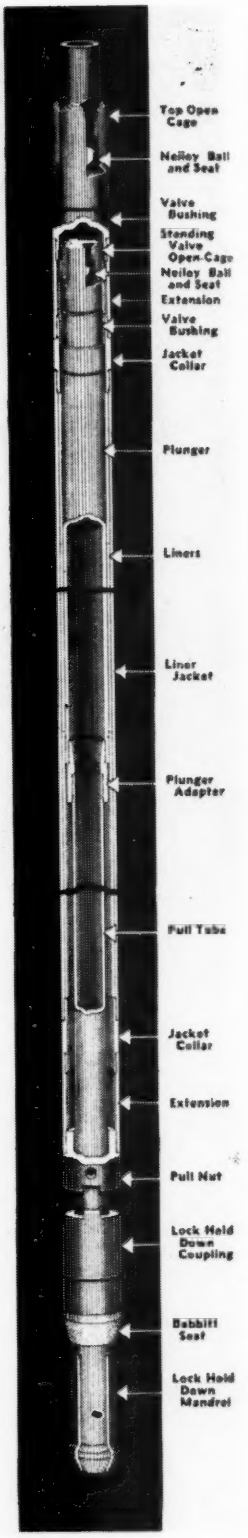

FIG. 3. Sectional liner traveling barrel rod pump assembly.

The pumps shown in Fig. 1 are all of one-piece, "full-barrel" construction, and the seating devices shown consist of assemblies of seating cups, or seating rings, which form a tight friction fit in the seating coupling, nipple, or barrel in which they are seated. Barrels also may be of "liner barrel" construction in which the wearing portion of the barrel may consist of sectional liners, or of a one-piece liner, inserted into a steel outer tube.

Fig. 2 shows a sectional liner tubing pump barrel assembly with a plunger but without valves and other fittings. In this case the liners are 12 in. long and are accurately honed and faced before assembling in the steel jacket. In order to obtain perfect alignment of the liner sections they are assembled on an expanding mandrel before inserting into the jacket. The end collars are tightened while the mandrel is in place and the mandrel is then removed. The sectional liner method of barrel construction permits barrels of any desired length to be manufactured to a high degree of accuracy without excessive machining difficulties.

Fig. 3 shows a sectional liner rod pump assembly of the traveling barrel type with a mechanical bottom lock hold-down mandrel for holding the pump in position and forming a seal to prevent fluid leakage. A complete bottom

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lock hold-down assembly consists of a mandrel, as shown in Fig. 3, and a special seating shoe that must be attached to the well tubing. A typical bottom lock hold-down and shoe assembly is shown in Fig. 4.

The cup or ring type hold-down is generally satisfactory for relatively shallow wells where bottom-hole temperatures are not excessively high, but the mechanical hold-down is preferred for wells more than 4000 ft in depth and where bottom hole temperatures are above 150 F. Mechanical hold-downs for top seating stationery barrel rod pumps also are used to some extent at the present time and doubtless they will become more popular for deep well applications.

In considering the type of pump to be selected for any particular application it is well to list a number of the more serious adverse conditions likely to be encountered in various pumping areas and the precautions to be taken to meet these conditions. In general, it can be said that the pumping of oil wells often presents the widest variety of adverse conditions to be met in a single installation of any pumping application with which the writer is familiar. These may include high discharge pressures, low intake pressures, severe abrasive conditions resulting from sand or other solids in suspension, severe corrosive conditions resulting from corrosive gases or salt waters; deposits of lime, salts, or other solids from the water pumped, paraffin deposits from the oil pumped, and the fact that the pump must handle liquids, permanent gases, and condensible vapors under the pressure and temperature conditions existing at the pump. Strong magnetic forces are often encountered that may interfere with valve action when the valves are made of magnetic material, and electrolytic corrosion is likely to occur as a result of using dissimilar materials.

The high differential pressures encountered in pumping deep wells require an effective sealing or packing means on the traveling valve, or plunger. For wells of extreme depth a closely fitted metallic plunger is almost always used to form a satisfactory seal with the barrel. Such plungers are commonly supplied with clearances of 0.001 in., 0.003 in., or 0.005 in. in the barrel. Such plunger fits are commonly referred to as —1, —3, and —5 fits, meaning that the plunger is 0.001 in., 0.003 in., 0.005 in., etc., smaller than the nominal ID of the barrel. The API tolerance for liner barrels is + 0.0012 in. — 0.0002 in. for all sizes, and the tolerance for plungers is + 0.0000 in., — 0.0005 in., making it possible for the fit of a — 1 plunger, for example, to vary from 0.0008 in. to 0.0027 in diametral clearance.

Most subsurface pump manufacturers provide both plain and corrugated plungers in various materials. It has never been conclusively demonstrated that either type of construction has any particular advantage over the other. Many operators feel that grooves facilitate lubrication of closely fitted plungers by providing spaces for the well fluid to accumulate in considerable quantities. However, there is considerable slippage past any plunger operating under usual conditions, where the differential pressure across the plunger is several hundred, or even thousands of pounds per square inch, and adequate lubrication should be provided with either type plunger if the fluid has any lubricating value. One possible advantage of a grooved plunger is that any solid particle, such as a sand grain or a steel chip, that gets between the plunger and the barrel and tends to score the barrel and plunger, may become lodged in a plunger groove and do no further damage; with a plain plunger, it could not escape from the finished surfaces until it traveled the full length of the plunger. On the other hand, a grooved plunger stroking out of a barrel affords a better opportunity to pick up solid material and carry it into the barrel.

● **Slippage past plungers.** In considering slippage past a closely fitted plunger it is pointed out that for all practical cases under which a pump is used, the flow between the plunger and the barrel is in the viscous range, so that leakage, or slippage, is inversely proportional to the absolute viscosity, and to the plunger length. It is directly proportional to the plunger diameter, the differential pressure between the two ends of the plunger, and the cube of the diametral clearance.

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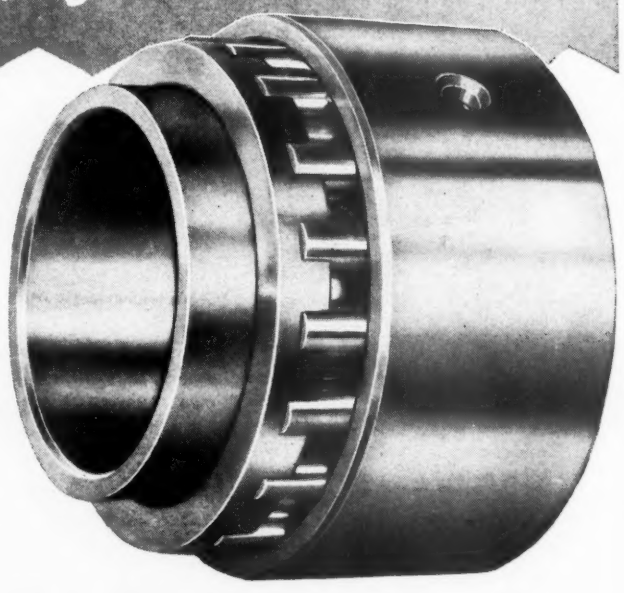

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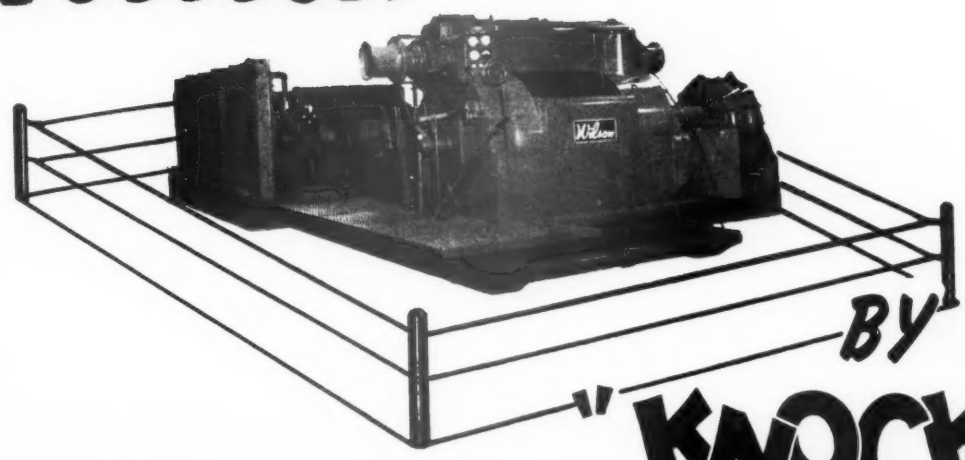

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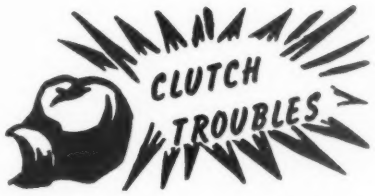

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commonly pumped will range from approximately 1 centipoise to 100 centipoises at the temperature existing at the pump setting, and in some cases the viscosity may be as high as 1000 centipoises. The slippage past the plunger of a particular plunger pump assembly with a given plunger fit, length, and diameter, may vary by as much as 100 to 1 under fairly common conditions, and as much as 1000 to 1 under extreme conditions, as a result of viscosity variations, with the same differential pressure across the plunger. Thus, it is seen that a plunger pump may operate with acceptable efficiency in a well producing a highly viscous oil, whereas the same pump may fail to deliver any oil to the surface when installed at the same depth in a well producing oil of low viscosity and operated at the same speed and stroke.

TABLE 1. Losses resulting from slippage past 2¼-in. pump plunger 48 in. long with 2000 psi pressure differential, 3 centipoise oil, with various plunger fits. Also slippage in percentage of pump displacement with fifteen 48-in. strokes per min.

Diametral clearance, in.	Slippage rate, cu in. per min.	Slippage loss in pump		
		Cu in. per min.	Bbl per day	Per cent of pump displacement
0.003	11.43	5.72	0.85	0.2
0.006	91.5	45.8	6.8	1.6
0.010	424.	212.	31.5	7.4
0.020	3390.	1695.	251.8	59.2

The following equation can be used to determine slippage losses past pump plungers with sufficient accuracy for most purposes:

$$Q = \frac{\pi D P C^3}{\mu L \times 2.32 \times 10^{-7}} \quad . \quad . \quad . \quad (1)$$

Where:
Q = slippage loss, cu in. per min,
D = plunger diameter, in.,
P = differential pressure across plunger, psi,
C = diametral clearance, in.,
L = length of plunger, in.,
μ = absolute viscosity, centipoises.

A specific application of this equation will serve to illustrate the importance of plunger fits for a pump of a particular bore and stroke, operating with various plunger fits, in fluids of various viscosities.

If we assume a 2¼-in. bore pump operating with a pressure differential of 2000 psi between the two ends of a 48-in. plunger, at a rate of fifteen 48-in. strokes per minute, in oil having a viscosity of 3 centiposes, and a diametral clearance of 0.003 in. between plunger and barrel, equation (1) becomes:

$$Q = \frac{\pi \times 2.25 \times 2000 \times 2.7 \times 10^{-8}}{3 \times 48 \times 2.32 \times 10^{-7}}$$

$$= 11.43 \text{ cu in. per min.}$$

Assuming that the volume of the barrel below the plunger is completely filled during the up-stroke, this rate of leakage can occur only during the up-stroke, or approximately one-half of the total time, and the net slippage past the plunger is 5.72 cu in. per min, or 0.85 bbl per day. The displacement of a 2¼-in. pump operating at fifteen 48-in. strokes per minute is 426 bbl per day and the slippage in this case is only about 0.2 per cent, which is insignificant. The results with this and other plunger clearances with 3 centipoise oil are shown in Table 1.

In the case of 0.020-in. plunger clearance, the slippage loss when pumping water with a viscosity of 1 centipoise would be 755 bbl per day, which is more than the pump displacement and it would be impossible to pump water to the surface, or to a level giving 2000 psi pressure differential across the plunger. When pumping oil with a viscosity of 100 centipoises, however, the slippage would be only about 7.5 bbl per day, or less than 1.8 per cent of the pump displacement, and a clearance of 0.020 in. is reasonably satisfactory for these conditions.

It is pointed out that slippage losses result directly in power losses, and it requires the same power to lift the plunger with 90 per cent of the fluid

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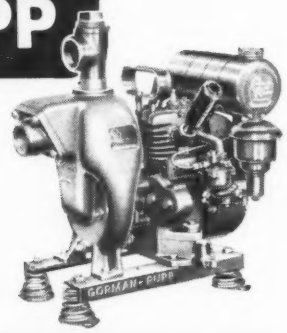

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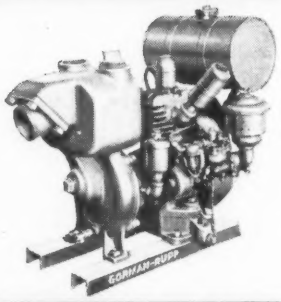

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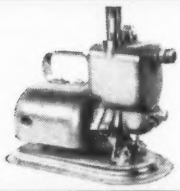

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slipping past the plunger during the up-stroke as is required with 1 per cent or less, slip. The energy dissipated in slippage losses results in an increase in temperature of the oil within the pump, and a decrease in viscosity, which further increases slippage losses. Excessive slippage losses also increase the chances of forming emulsions, where water is produced with the oil.

Close plunger clearances are relatively more important with small bore pumps than with larger bores, inasmuch as the displacement for a given stroke length and speed varies as the square of the diameter, whereas slippage varies as the first power of the diameter. Close plunger clearances are especially important in small pumps operated at extremely low speeds, as used in stripper wells in some areas. It is believed that the method outlined above is satisfactory for evaluating maximum slippage to be expected in all cases.

Relatively clean oil or water can be pumped satisfactory with cups when the cups are properly selected for the load, well fluid, and temperature, and are properly installed. Carefully controlled tests have shown that cups will cut out rapidly at common pump pressures if they fail to expand properly and prevent slippage, but they will conform to the barrel and form a tight seal if they can be operated a few hours without appreciable slippage. For this reason a traveling valve consisting of cups and composition rings, as shown in Fig. 1 "C," has given very satisfactory service. The composition rings form a satisfactory seal during the "breaking in" period and prevent damage to the cups resulting from slippage. When cups are allowed to "wear in" in this manner they will operate with no measurable slippage, and automatically take up wear until they are completely worn out. After the cups are worn in there is no load on the rings and very little wear. The rings serve an additional purpose throughout the life of the cups in that they act as a guide to maintain the cups in proper alignment and as a wiper to remove any abrasive material from the barrel on the down-stroke. Similar conditions result with the so-called repack, or coil packing, used in combination with cups and the repack will expand radially to take up for wear.

● **Effect of gases and vapors.** In selecting pumping equipment for oil wells it should be remembered that in a majority of cases some of the constituents of the fluid being pumped are above, or near, their boiling points at pressure and temperature conditions existing within the pump, and large volumes of dissolved gases and vapors may be set free with a slight drop in pressure of the well fluid, in addition to the free gas in the fluid. For this reason it is very difficult to pump some wells down, and many wells will apparently pump off with several hundred feet of fluid standing in the hole because the condensible vapors, and gases, occupy the entire displacement volume of the pump, and the pressure below the plunger cannot be raised to that of the tubing pressure (which is necessary before the traveling valve can open and deliver oil to the tubing) without a relatively high intake pressure, which decreases the compression ratio. On the down-stroke the vapors may condense and occupy a very small volume without an appreciable increase in pressure, and only the permanent gases are effective in increasing the pressure in accordance with the gas laws.

There are two precautions to take to minimize the adverse effects of vapors and gases:

1. The compression ratio should be made as high as possible. This is accomplished by using a closed-cage type valve below the plunger with a stationary barrel pump, or a valve above the plunger with a traveling barrel type pump; spacing the pump so the traveling valve and standing valve come as

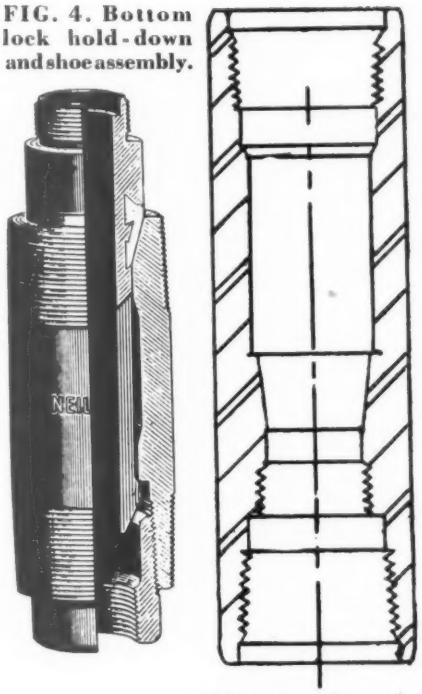

FIG. 4. Bottom lock hold-down and shoe assembly.

FIG. 5 Standing valve seating shoe with oversize anchor connection.

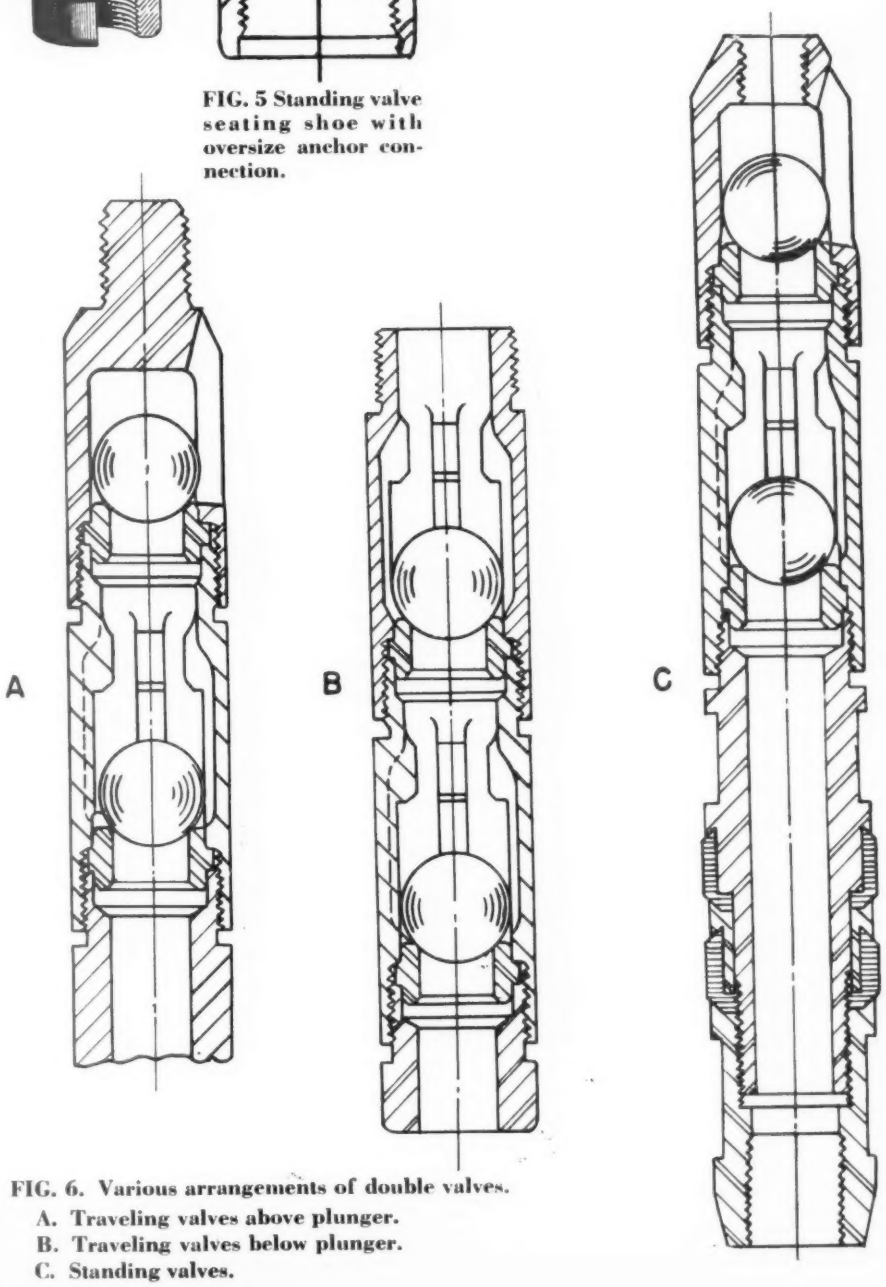

FIG. 6. Various arrangements of double valves.
A. Traveling valves above plunger.
B. Traveling valves below plunger.
C. Standing valves.

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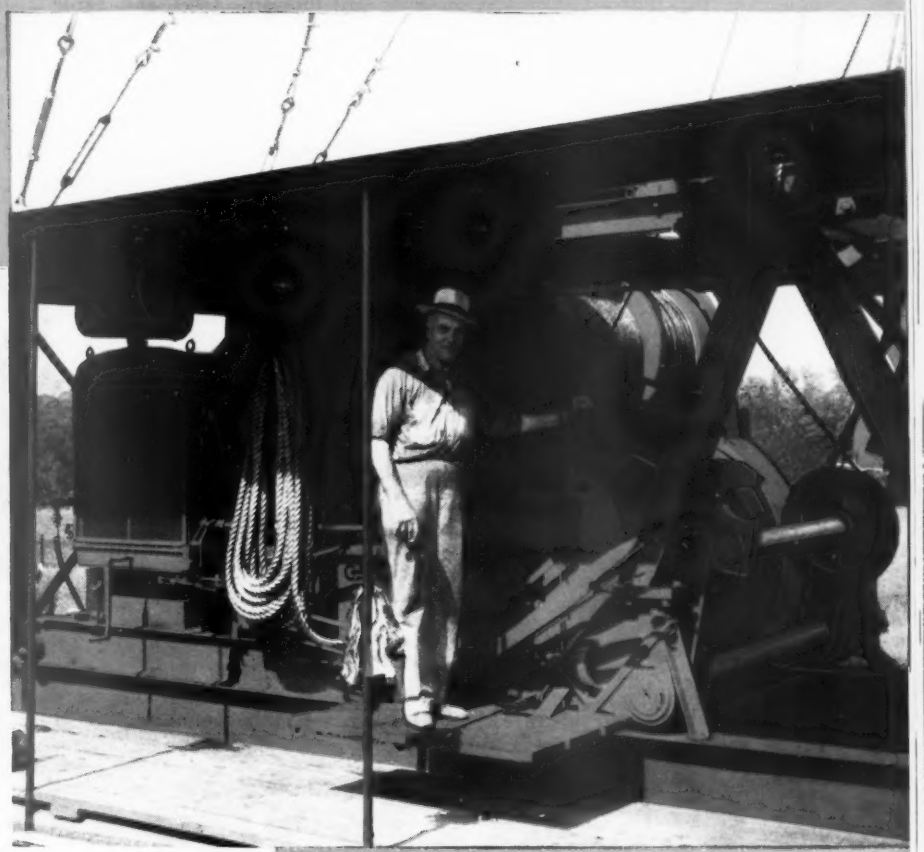
D. O. LYNN

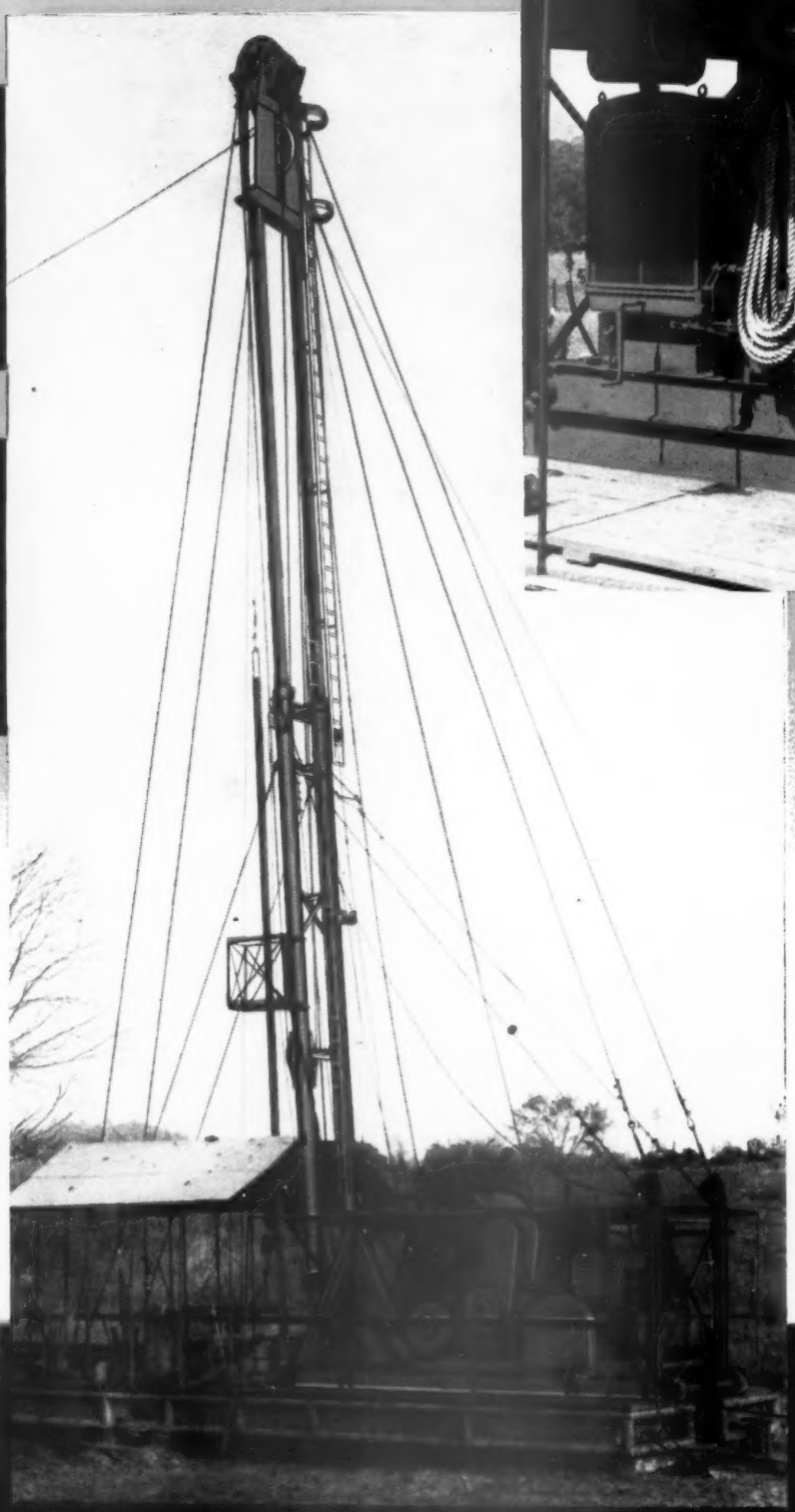
BEASLEY AND LYNN

PHOTO AT RIGHT: Note the rear guy lines are anchored to subframe in which are mounted the water tanks for ballast, making it necessary to provide deadmen for front guy lines only.

PHOTO AT LEFT: Rig can be converted to a draw works in the field for rotary operations.

M" CABLE TOOL RIG BREAKS RECORDS





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near to each other as possible at the lowest position of the rods, without making contact; and using as long a stroke as possible with the equipment available.

2. Flow velocities and turbulence at the pump inlet should be kept at a minimum. This is accomplished by using the largest standing valve possible, and a suitable gas anchor with the largest possible flow passages.

In the case of tubing pumps, the choice of regular or oversize standing valves may be dictated by strength requirements of the valve cage for use in deep wells inasmuch as the cage may be subjected to the sucker-rod load when spacing the pump, or in the case of a rod break. The oversize standing valve shown in Fig. 1 "B" has a flow area nearly double that of the standard valve body and seat illustrated in Fig. 1 "A," in the 1¾ in. size, and still may be pulled through the pump barrel.

In general, where gas anchors are used, the pressure drop through the gas anchor pipe is greater than that through the standing valve because of the greater length of the gas anchor flow passage, and in many cases the ID of the gas anchor is less than that of the standing valve. It is important to make this connection as large as possible for handling extreme gassy or volatile fluids. It has been customary in the past to attach the gas anchor directly to the threaded connection in the tapered cup nut or valve body, and this thread for a 1¾-in. valve was usually a ¾-in. pipe thread. A 2¼-in. valve is commonly equipped with a connection for 1-in. line pipe, and 1½-in. line pipe is often used with a 2¾-in. standing valve. Fig. 5 shows a design for a standing valve seating shoe that permits the use of larger gas anchor connections in standard line pipe sizes, and Table 2 shows the effect on flow velocities and pressure drops for a particular case when using a 10-ft gas anchor and substituting 1¼-in., 1½-in., and 2-in. line pipe sizes for the ¾-in., 1-in., and 1½-in. sizes previously used.

It is noted that in the cases of the 1¾-in. and 2¼-in. bore pumps there is a reduction in pressure drop of 89 per cent and 86 per cent, respectively, and the flow remains in the viscous region when using oversize gas anchors. Both factors can have a very great effect in preventing the liberation of dissolved gas and condensible vapors, and should result in much more efficient pump operation and in a higher effective productively of a well producing highly volatile, or gassy oil.

● **Double valves.** Fig. 6 shows various arrangments of double valves for traveling and standing valves.

There has been considerable discussion concerning the desirability of two balls and seats in series and it has been argued that the load cannot distribute itself between the two valves, and only one will form a tight seal on any particular stroke. This line of reasoning has led to the conclusion that two valves in series cannot be of any particular advantage. Experience has shown, however, that two valves in series will give much longer service than a single valve if the valve life is determined by wear, or fluid cutting, rather than by corrosive action. This result appears entirely logical where sand or other solid material is lifted with the oil. In such cases failure is likely to occur as a result of fluid cutting when a solid particle is caught between the ball and seat and prevents perfect seating. A pressure differential of 2000 psi will produce a jet of fluid having a velocity of over 500 fps and such a fluid velocity can easily damage the lapped valve seating surface on balls and seats in a short time, especially if the fluid jet carries solid material in suspension.

The life of a ball and seat will depend largely on the number of times it is subjected to the action of such fluid jets, and this can be decreased greatly by the use of double valves, inasmuch as a jet cannot occur until both balls are held off their seats during the same stroke. For example, if conditions are such that a single ball and seat is prevented from seating properly one out of each 100 strokes, on the average, the chances of both of two valves in series failing to seat properly will be reduced to 1 in 10,000 strokes. Furthermore, when this occurs the pressure drop will be distributed between the two leaking valves and the cutting action will be less severe than with a single valve.

The extra first cost of double valves is so small in comparison with the av-

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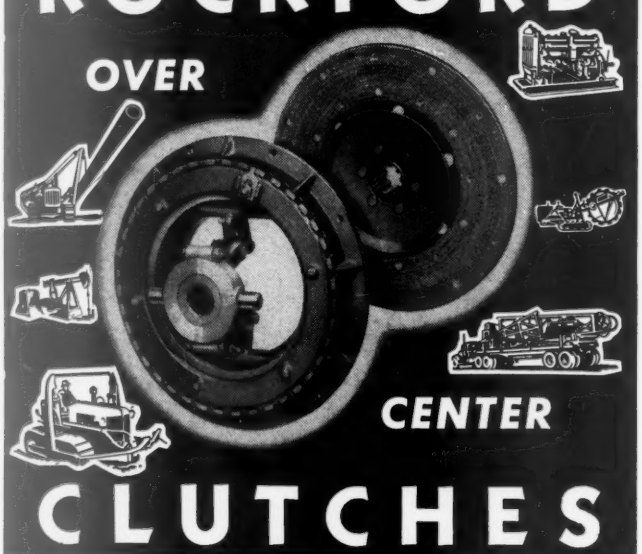

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erage pump pulling job that the use of double valves should be well justified by the savings resulting from fewer pulling jobs. Also, fewer balls and seats should be required over a long period of operation because of the much greater life to be expected under average conditions.

The only apparent objection to double valves is the possibility of affecting pump efficiency by the slight added pressure drop at the pump inlet, when pumping highly volatile and gassy fluids, especially when it is necessary to pump the well down to a low fluid level to produce its allowable. Any influence on production can be determined by making alternate runs with single and double standing valves. In the case of traveling valves, the use of double valves of standard size cannot adversely affect production rates. The contents of the pump barrel must be raised to the tubing pressure of several hundred, or several thousand, psi before the traveling valve will open, in any case, and the extra pound or two required to overcome the resistance of an additional valve is of no significance.

TABLE 2. Velocity and pressure drop through regular and oversize gas anchors 10 ft long—54-in. stroke, 20 spm, 100 centipoise oil.

Regular anchor					Oversize anchor				
Pump bore, in.	Pipe size, in.	Max. vel, fps	Type flow	Pressure drop, psi	Pipe size, in.	Max. vel, fps	Type flow	Pressure drop, psi	Decrease in pressure drop, per cent
1¾	¾	21.3	Turbulent	21.2	1¼	6.43	Viscous	2.3	89
2¼	1	21.6	Turbulent	16.7	1½	9.19	Viscous	2.4	86
2¾	1½	13.7	Turbulent	4.5	2	8.35	Turbulent	1.3	71

● **Corrosion.** In some areas resistance to corrosion of the materials used in subsurface pumps is of major importance. A wide variety of alloy irons, steels, nonferrous alloys, and elements have been used to combat corrosive conditions in various districts. Some of the corrosive agents commonly found in various districts are hydrogen sulphide, salt waters containing sodium chloride, calcium chloride, magnesium chloride, and other salts, and in some cases carbon dioxide and oxygen have been reported. Although the corrosion problem cannot be covered adequately at this time, it is pointed out that many alloys having suitable resistance to corrosion are unsatisfactory because of insufficient hardness or resistance to wear.

Some materials are very satisfactory in some corrosive areas and entirely unsatisfactory in others. Many patented alloys that resist corrosive conditions and wear to a remarkable degree are used for various subsurface pump parts. Most of these are relatively expensive materials and it is necessary for the operator to determine experimentally whether they are economically justified in a particular area. Of the more common types of materials, alloy irons have given very good service for both barrel and plunger materials, and alloy irons are widely used at present both in one-piece and in sectional-liner type barrels and are giving good service even under rather severe salt water and sulphide corrosive conditions.

Aside from the selection of most suitable materials, it is suggested that consideration be given to the possibility of reducing corrosion by reducing maximum temperatures. The compression of gas within the pump barrel can result in very high temperatures, and a rise in temperature always greatly increases the speed of a chemical reaction. As a rough approximation the chemist Ostwald estimated that the speed of a chemical reaction was about doubled for each 10 C (18 F) rise in temperature.

In pumping a well with a pressure of 2000 psig at the pump, any gas collected in the pump barrel must be compressed to this value before any fluid can be delivered to the tubing. If oil and methane are being pumped from a well having a bottom-hole temperature of 150 F. with an intake pressure of 20 psia, the temperature of the methane can rise to a value above 1300 F as a result of adiabatic compression, with this com-

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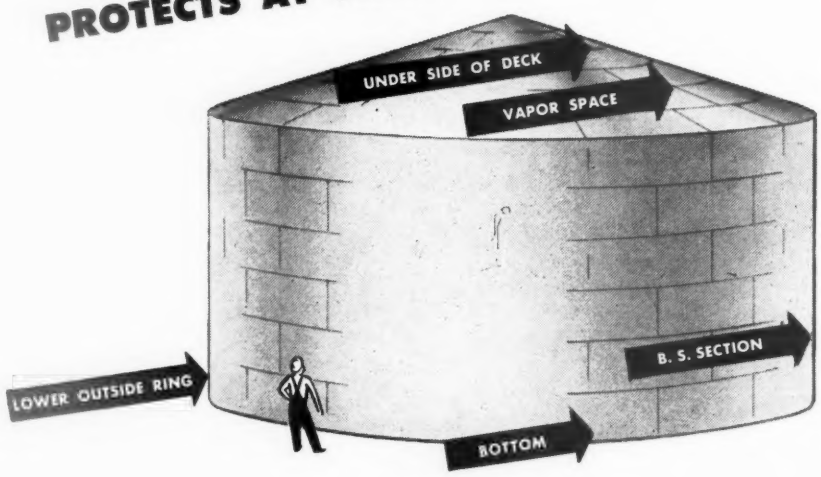

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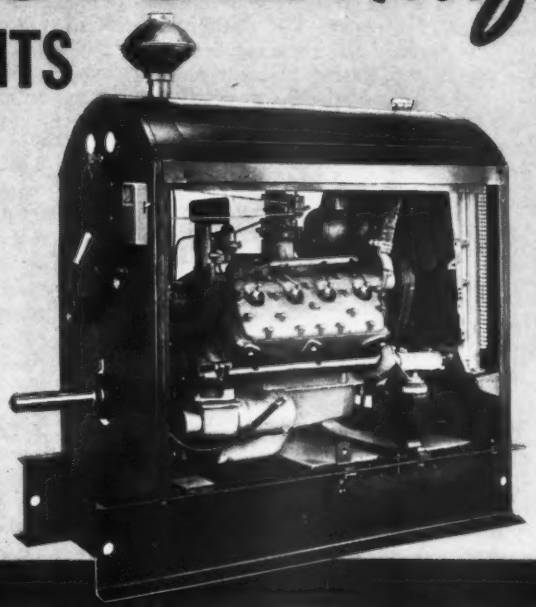

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20	.54	.90	.072	.12	.25	.38
25	.68	1.13	.09	15	.30	45
30	.82	1.36	108	.18	.34	.51
35	.95	1.58	.126	.21	.39	.59
40	1.08	1.80	.144	.24	.44	.66
45	1.23	2.04	.162	.27	.49	.74
50	1.35	2.25	.18	.30	.54	.81
60	1.64	2.72	.216	.36	.63	.95
70	1.90	3.16	.252	.42	.71	1.07
80	2.16	3.60	.288	.48	.88	1.32
90	2.46	4.08	.324	.54	.98	1.48
100	2.70	4.50	.360	60	1.08	1.62

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pression ratio of over 100 to 1 in a single stage. Still higher temperatures can result from higher discharge pressures, lower intake pressures, higher bottom-hole temperatures, or any combination of these factors. For methane, which is the major constituent of most natural gas, the ratio of specific heat at constant pressure to specific heat at constant volume:

$$\frac{C_p}{C_v} = k = 1.316 \quad \text{and}$$

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}} = \left(\frac{P_2}{P_1}\right)^{0.24} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Where:

T_1 = initial absolute temperature,
T_2 = final absolute temperature,
P_1 = initial absolute pressure,
P_2 = final absolute pressure.

From this relation, and knowledge of inlet pressure, discharge pressures, and bottom hole temperatures, the maximum temperature obtainable by adiabatic compression can be calculated. Actual temperatures probably are considerably lower because of the cooling action of a relatively small bore pump surrounded by oil.

Any quantity of permanent gas possible to pick up on a single stroke will occupy a very small volume at such discharge pressures, and its heat capacity will be small. The high temperatures developed, however, will give a condition similar to that resulting from cavitation in high speed rotary devices such as pumps and turbines, which may cause direct damage to finished surfaces as a result of the high temperature, and corrosive action undoubtedly will be accelerated as a result of this effect. The traveling valve ball and seat probably is most seriously affected by the hot gas inasmuch as the gas will accumulate above the liquid in the pump barrel and will be forced through the traveling valve just as it reaches its maximum pressure and temperature. If a double traveling valve is used, the upper one is protected from high temperatures by liquid trapped between the two valves, and this is another reason why a double traveling valve should give superior results. The standing valve should not be affected by the heated gas since it is submerged in oil.

The only apparent precautions to minimize the effects of hot gases are to utilize as slow a pumping speed as possible to obtain the required production, and to allow as much time as possible for cooling during compression. The quantity of free gas in the pump can be minimized by maintaining large openings at the pump inlet by using oversize standing valves, and gas anchors, and the heat capacity of the hot gas will be decreased in proportion to its volume.

● **Effect of stretch of sucker rods and tubing.** Space will not permit a survey of the problems resulting from elasticity of sucker rod and tubing strings, and the practice of using tapered rod strings to effect savings in rod costs and to minimize rod stresses.

Such a discussion would be a repetition of previously published information.[1, 2, 3] Figs. 7 and 8 show curves that can be used, with correction factors in Tables 3 and 4, and the accompanying explanations, to determine plunger strokes and pump displacements corresponding to various polished rod strokes for all common rod and tubing combinations, and densities of well fluids for seven commonly used pump bores.

TABLE 3. Correction for rod and tubing combinations.

Rods, in.	Tubing, in.	Factor F_1
⅝	2	1.44
	2½	1.36
	3	1.30
¾	2	1.08
	2½	1.00
	3	0.941
⅞	2½	0.787
	3	0.729
	4	0.690
1	2½	0.648
	3	0.590
	4	0.551

TABLE 4. Correction for gravity of fluid.

Sp. gr.	°API gr.	Factor F_2
1.25		1.43
1.20		1.37
1.15		1.31
1.10		1.26
1.00	10	1.14
0.966	15	1.10
0.933	20	1.07
0.902	25	1.03
0.875	30	1.00
0.850	35	0.972
0.825	40	0.943
0.802	45	0.916
0.780	50	0.892

The following notes show methods for determining plunger strokes with uniform rod strings and with tapered strings. (See Appendix "A").

It is pointed out that these curves do not take account of dynamic effects, which vary with the pumping speed, and may result in "over-travel" of the plunger at high speeds. The displacements given by the curves, therefore, can be considered as minimum values to be expected. The curves were computed on the assumption that some grade of steel rods would be used and a value of 29 ×

FIG. 8. Displacement of plunger pumps in barrels per 24-hr. day = $D_1 \times$ SPM.

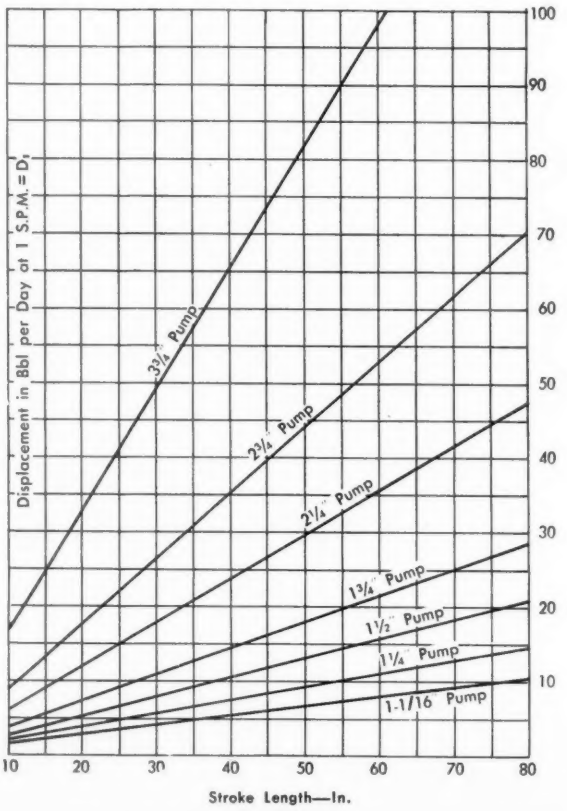
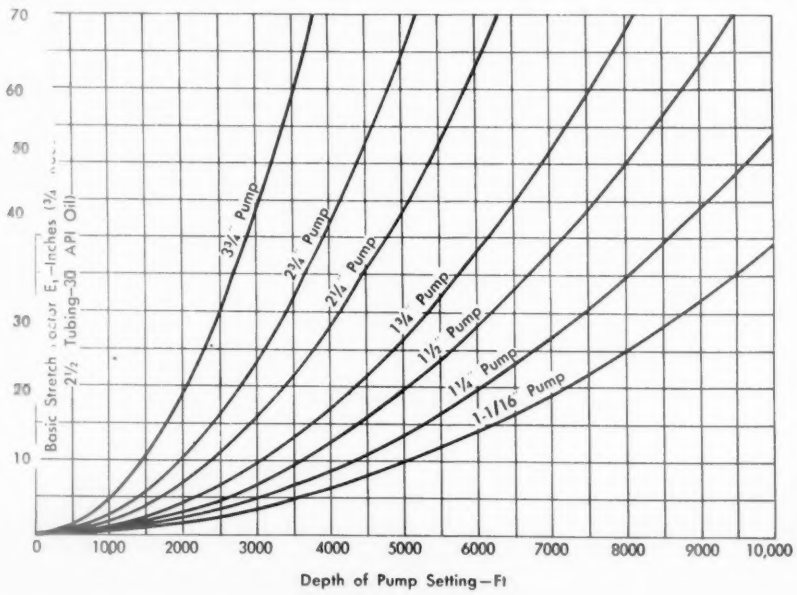
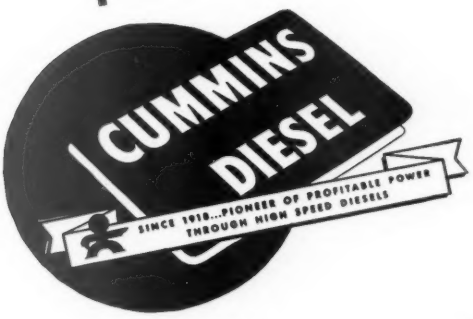


FIG. 7. Curves for determining lengths of plunger stroke.





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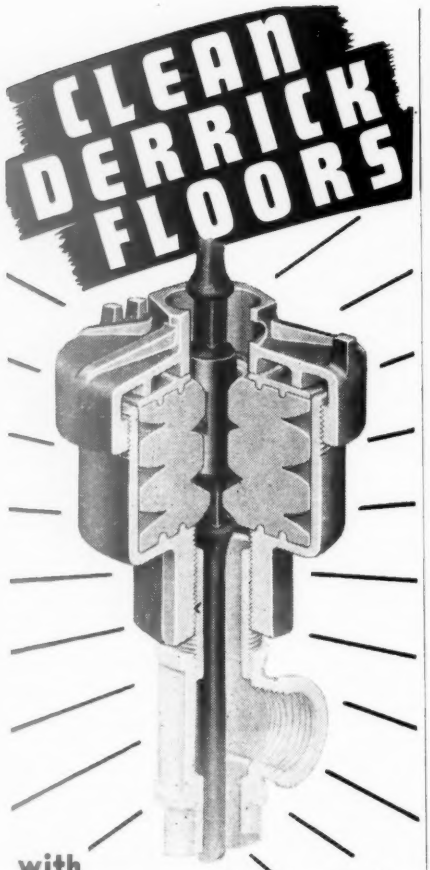

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10^{-6} for the modulus of elasticity was assumed. If nonferrous rods are used an appropriate correction must be made for the modulus of the material.

Before closing it should be emphasized that the largest pump does not always produce the most oil, with all other factors identical. For example, if we consider the relative displacements of 1¾-in., 1½-in., and 1¼-in. bore pumps when operated at a depth of 4000 ft. with a 36-in. polished rod stroke, at 20 spm, with ⅝-in. sucker rods and 2-in. tubing, producing oil of 30° API gravity, it is seen from Figs. 7 and 8 that a 1¾-in. bore pump will have net displacement of 84 bbl per day, a 1½-in. bore pump has a displacement of 126 bbl per day, and that of a 1¼-in. pump is 88 bbl per day. If maximum displacement is wanted, the 1½-in. pump is the logical selection, but if a displacement of 80 to 90 bbl per day is sufficient, the 1¼-in. pump is preferable to the 1½-in. or the 1¾-in. pumps because of the lighter load on the sucker rods and surface equipment.

APPENDIX "A"

To determine pump plunger stroke with uniform rod strings:

$S_2 = S_1 - (E_1 \times F_1 \times F_2)$,

S_2 = actual plunger stroke,

S_1 = polished rod stroke,

E_1 = basic stretch factor from Fig. 7 for proper depth and pump size,

F_1 = correction factor from Table 3 for actual rod and tubing combination in well,

F_2 = correction factor from Table 4 for gravity of fluid.

To determine pump displacement:

1. Find value of D_1 (Fig. 8) corresponding to actual plunger stroke and pump size.
2. Displacement in bbl per day = $D_1 \times$ spm.

Example:

Well data

Depth to pump, 4500 ft.
Pump size, 1¾ in. ID.
Rods, ⅞ in.
Tubing, 2½ in.
Length of polished rod stroke, 48 in. = S_1.
Spm, 20.
API gravity, 25.

From Fig 7, E_1 for 1¾-in. pump at 4500 ft. = 21.6 in.

From Table 3, F_1 for ⅞-in. rods, 2½-in. tubing = 0.787.

From Table 4, F_2 for 25° API = 1.03.

Plunger stroke, $S_2 = 48 - (21.6 \times 0.787 \times 1.03) = 30.5$ in.

From Fig. 8, $D_1 = 10.8$ for 30.5-in. stroke, 1¾-in. pump.

Displacement $= 10.8 \times 20 = 216$ bbl per day.

To determine plunger stroke with tapered sucker rod string:

Let A = length of ⅝-in. rods in string,
B = length of ¾-in. rods in string,
C = length of ⅞-in. rods in string,
D = length of 1-in. rods in string,
Y = total length of rod string.

$$\text{Plunger stroke } S_2 = S_1 - E_1 F_2 \left[(F_{1A} \times \frac{A}{Y}) + (F_{1B} \times \frac{B}{Y}) + (F_{1C} \times \frac{C}{Y}) + (F_{1D} \times \frac{D}{Y}) \right] \quad (3)$$

Where:

S_1 = polished rod stroke,

E_1 = basic stretch factor from Fig. 7 for depth and pump size,

F_{1A} = correction factor from Table 3 for ⅝-in. rods in tubing used,

F_{1B} = correction factor from Table 3 for ¾-in. rods in tubing used,

F_{1C} = correction factor from Table 3 for ⅞-in. rods in tubing used,

F_{1D} = correction factor from Table 3 for 1-in. rods in tubing used,

F_2 = correction factor from Table 4 for gravity of fluid.

Note that any particular term in parenthesis is used only if there is a rod size in the string corresponding to the letter (A, B, C, or D) appearing in this term. For example, if a tapered string consists only of ⅝-in. and ¾-in. rods equation (3) becomes:

$$S_2 = S_1 - E_1 F_2 \left[(F_{1A} \times \frac{A}{Y}) + (F_{1B} \times \frac{B}{Y}) \right]$$

Example:

Depth to pump, 4500 ft.
Pump size, 1¾ in.
Rods, 2400 ft, ¾ in. = B.
2100 ft, ⅞ in. = C.
Tubing, 2½ in.
Length of polished rod stroke, 48 in. = S_1.
API gravity, 25°.

From Fig. 7, E_1 for 1¾-in. pump at 4500 ft = 21.6 in.

From Table 3,
F_{1B} for ¾-in. rods and 2½-in. tubing = 1.00.
F_{1C} for ⅞-in. rods and 2½-in. tubing = 0.787.

From Table 4, F_2 for 25° API oil = 1.03.

Using ¾-in. and ⅞-in. rods, equation (3) becomes:

$$S_2 = S_1 - E_1 F_2 \left[(F_{1B} \times \frac{B}{Y}) + (F_{1C} \times \frac{C}{Y}) \right]$$

$$= 48 - (21.6 \times 1.03) \left[(1 \times \frac{2400}{4500}) + (0.787 \times \frac{2100}{4500}) \right]$$

$$= 48 - 22.25\ (0.533 + 0.367)$$
$$= 48 - (22.25 \times 0.90)$$
$$= 28\text{-in. plunger stroke.}$$

References

1. E. A. Stephenson, "Stretch of Sucker Rods," *Oil and Gas Journal*, October 5, 1946.
2. E. N. Kemler, "The Design of Tapered Sucker Rod Strings," *The Oil Weekly*, August 2, 1943.
   "How to Determine Proportions of Sucker Rod Strings," *The Oil Weekly*, August 7, 1944.
3. B. B. Wescott and C. N. Bowers, "Economical Selection of Sucker Rods," *AIME Transactions*, Vol. 114, 1935.

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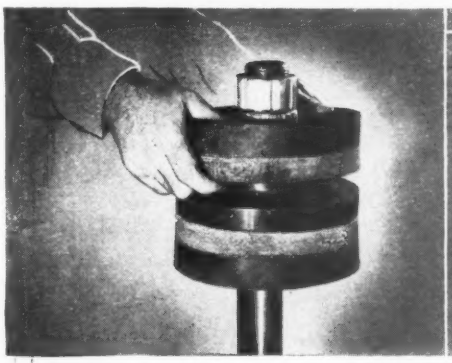

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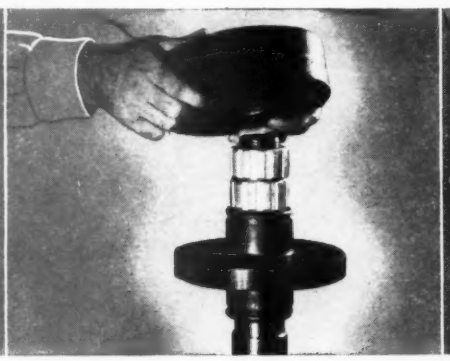

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Fabricating a section of pipe at a 45-deg. angle, with use of an elbow joint, in construction of the new 12-in. pipe line of the Socony-Vacuum Oil Company, Inc., in Venezuela.

Placing a stringer bead, preparatory to welding one of the final joints of the line near the manifold house of the Compania Consolidada de Petroleo.

Installation of new Venezuelan pipe line*

FEW of the difficulties normally encountered in construction of a pipe line were faced when the Socony-Vacuum Oil Company, Inc., installed its new 103-mile line in the state of Anzoategui, Eastern Venezuela.

EXCLUSIVE

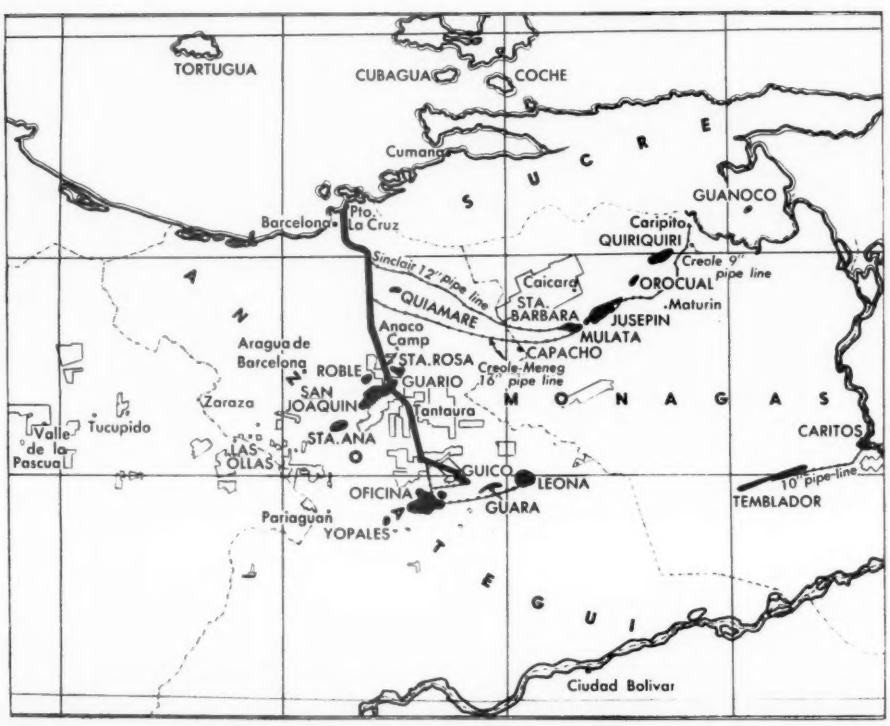
This new line went into full operation on September 25, 1947, with the loading of 114,500 bbl of Guico crude on the tanker *Mobilgas*, destined for the Socony-Vacuum refinery at Paulsboro, New Jersey.

The line's construction required 10½ months from the date of a decision to go ahead with it until the installation was completed. It is the telescope type of line and is 12 in. in diameter for its entire length, linking Puerto La Cruz on the Caribbean Sea with Socony-Vacuum's 59 wells in the Guico field. This field includes South and West Guico and Nipa, with a daily production of about 22,000 bbl.

Much of the need for coating the pipe itself, or for providing otherwise for protection against corrosion, was eliminated by the fact that the line is entirely above ground with exception of several stretches where it crosses streams and passes through small towns.

For the most part, the route of the

Map showing the route of the new 12-in. pipe line of the Socony-Vacuum Oil Company, Inc., in Venezuela. Route is indicated by heavy, dark line to Guico.



*Prepared especially for *The Petroleum Engineer* by Socony-Vacuum Oil Company, Inc.

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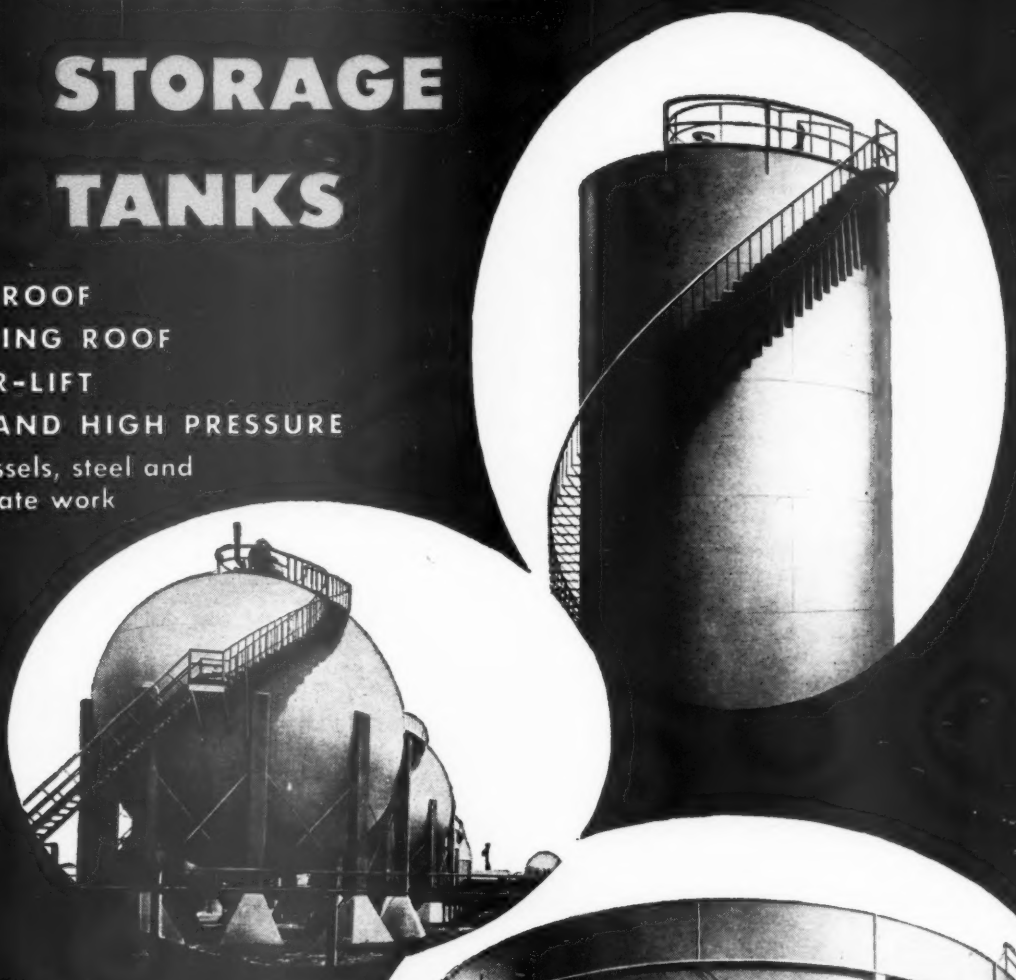

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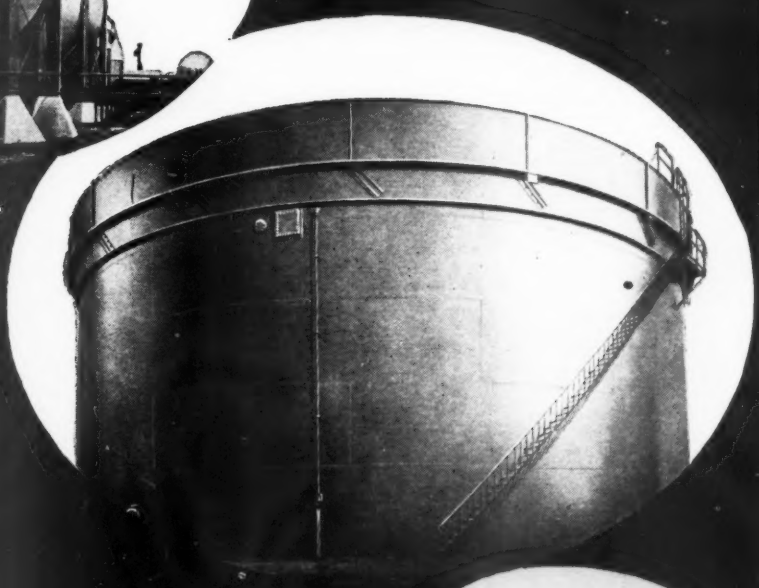

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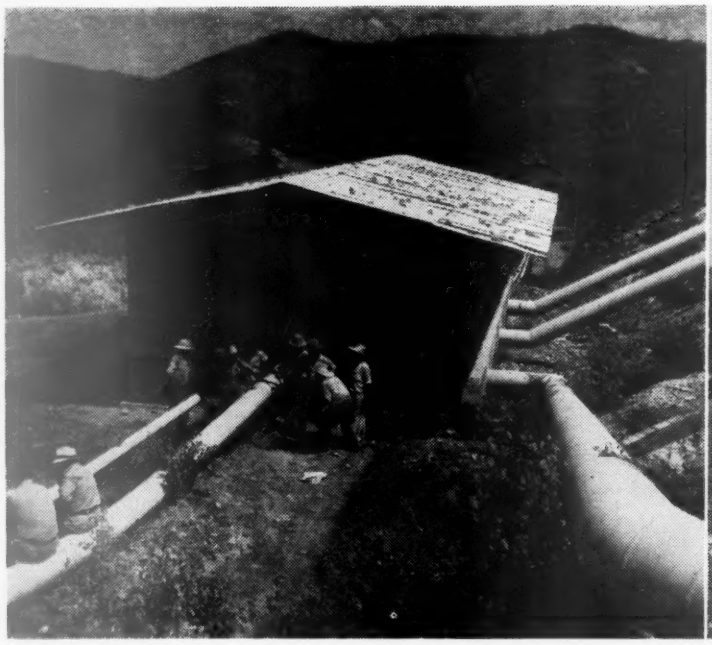

Left, cut being made in an existing pipe line at manifold house in order to tie in the new 12-in. Al Seelinger, right, superintendent of the pipeline, near a scraper trap at the northern terminus of the pipe line.

pipe line follows the highway between Oficina and Puerto La Cruz, the exception being a span of about 20 kilometers where it swerves from the highway to the line's southern terminal in the Guico field. A telephone circuit will parallel the line for its entire length.

During construction of the line, two major streams and several smaller ones were crossed during the dry season in order to take advantage of minimum water-level conditions. In every case, the streams were traversed with dredged channels and full weight, coated and wrapped pipe on the bottoms. The two major streams crossed were the Rio Guanipa and the Rio Neveri.

No pumping station is needed at the line's terminus in the Guico area, where the line is supplied by 4 gathering stations, which pump directly into it at a pressure of about 500 psi. A pumping station is under construction, however, at the line's main camp and tank farm at Anaco, 710 ft above sea level, which will enable the company to serve the San Joaquin area with a six-mile spur.

Ship-loading line of Socony-Vacuum on the right looking northward from the manifold house.

Completion of the pumping station at Anaco is scheduled for early next year, and this will boost the daily throughput of the line to Puerto La Cruz to approximately 31,000 bbl daily. The San Joaquin field has 21 producing wells with a daily output of 6500 bbl.

At present, the line is carrying about 24,000 bbl daily from the Guico field, compared with a maximum potential capacity of 70,000 bbl at an operating pressure of 825 psi.

At its start in the West Guico field, the new Socony-Vacuum pipe line is 930 ft above sea level, reaching a maximum elevation of 1015 ft a short distance away. At Puerto La Cruz, it empties into six 300-ft tanks with a capacity of 90,000 bbl each.

For a week or so before the loading of the tanker *Mobilgas*, and after the line had been tested, it was in use to accumulate sufficient cargo in the company's loading facilities and storage tanks at Puerto La Cruz.

Until its new pipe line was completed, Socony-Vacuum used the Mene Grande line to transport its crude from the Guico field to the seacoast. It is still using the Mene Grande line for transportation of the higher wax-content oil from the company's San Joaquin field, about 40 miles nearer to the seacoast.

In addition to the Guico and San Joaquin fields, Socony-Vacuum holds concessions from the Venezuela government on 600,000 more acres of land, which, if and when oil is found on it, will be served also by the new pipe line after supplementary gathering lines are laid to these areas. ★★★

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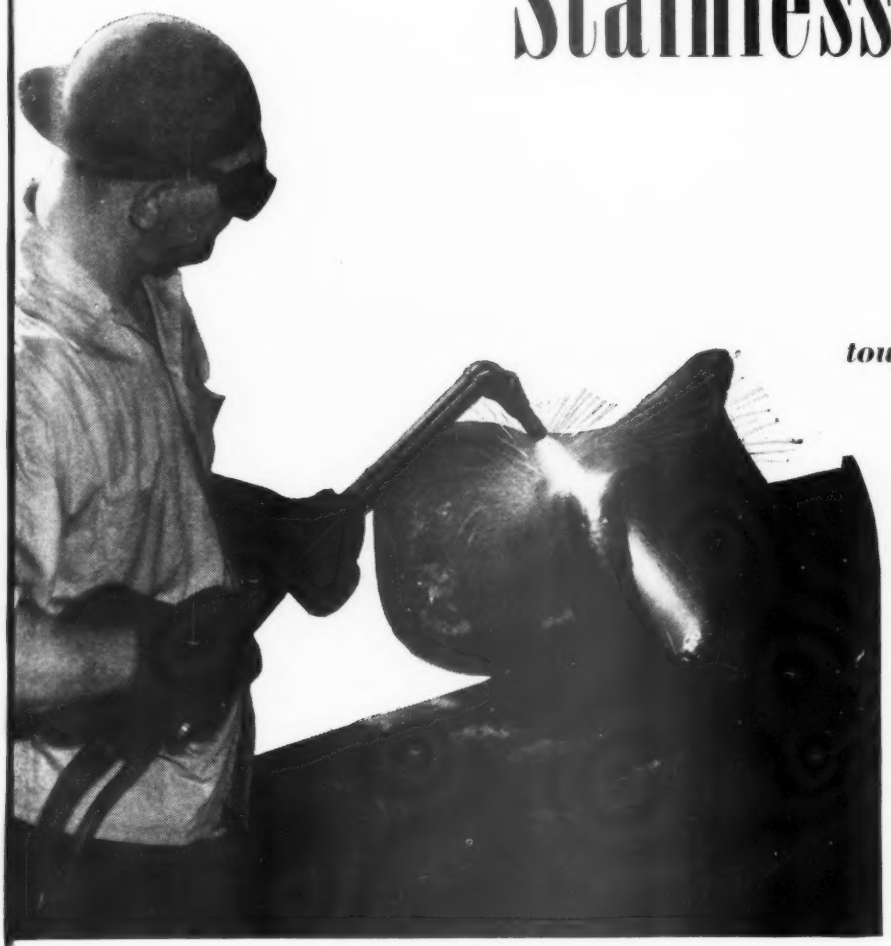

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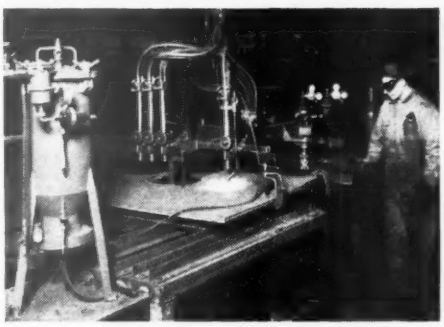

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New technique designed for cementing casing

By K. MARSHALL FAGIN, *Field Editor*

EXCLUSIVE

In the endless struggle to manufacture equipment and design methods that will enable operators to cement casing in wells with a solid and impervious wall of cement between the casing and the wellbore, cementing tools and a method designed as an improvement have recently been developed.*

Most operators are familiar with the numerous improvements that have been made during the last 20 years in cement and cementing practice as longer strings of casing have been cemented in deeper formations under higher temperatures and pressures. It is difficult for an operator to tell whether his use of different cement, mixing and pumping equipment, casing centralizers, wall scratchers, shoes, plugs, valves, or differences in the placing of the cement slurry through different manipulation of the equipment is primarily responsible for a successful cement job.

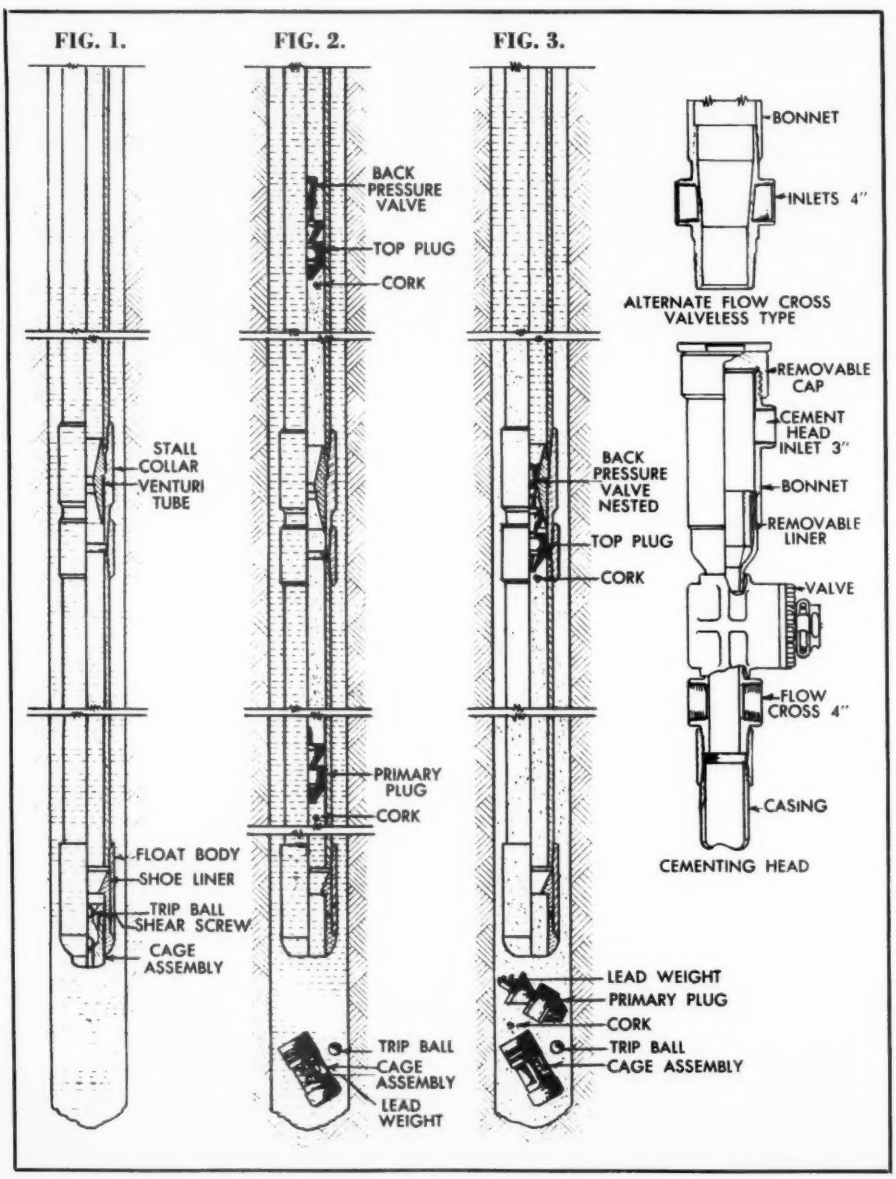
It is likewise difficult to tell exactly why a cement job fails. The main reason for these uncertainties is simply this: The slurry is pumped into the casing of the well and sets up out of sight. A job either holds or fails, and the reason for either is largely a matter for conjecture. The condition of the cement behind the casing cannot be examined and tested.

Temperature surveys can now be run in the casing soon after cementing to locate the top of the cement and the relative quantity behind the casing. Radioactivity surveys can be run at any time to obtain similar data on the relative quantity of cement in place behind each foot of pipe, if a radioactive tracer was placed in the slurry. Neither of these methods can tell the condition of the cement, however, that is whether it has set up properly as a solid plug between the casing and the walls of the wellbore or whether it is contaminated and contains mud balls, oil and/or gas pockets, or mud-filled channels.

With these multiple uncertainties in mind, every new piece of cementing equipment and every new method is scrutinized and tested continuously by most operators. The improvements claimed for the newly announced method are as follows: (1) full bore discharge opening from the bottom of the casing to the wellbore, when the casing shoe is suspended a few feet off bottom; (2) complete segregation of the cement slurry from the drilling mud and well fluids as the slurry is pumped down the casing; (3) a piston-like back pressure valve in the top plug to seal and lock in a stall collar and prevent the slurry from flowing back into the casing, and (4) a cementing head, or lubricator, for placing and pumping cementing plugs into the casing under pressure.

The accompanying diagrams illustrate the tools and method announced recently. Fig. 1 shows a cross-section of the casing suspended in a well with the new float shoe and stall collar assemblies. The stall collar contains a venturi-shaped tube designed to produce very little, if any, additional restriction to downward flow of fluids or slurry through the casing. The casing itself, of course, provides a certain restriction to flow in either direction at high velocities.

The float shoe contains a float valve cage assembly that is fastened to a liner in the shoe by shear screws. After the casing has been run, a trip ball is dropped through the drilling fluid or water in the casing to the position shown in Fig. 1. The casing is filled to the surface with drilling fluid, or water, and the lines from the cementing truck are connected to the cementing head (Fig. 3). The cement slurry is pumped up slowly with the head valve open and the



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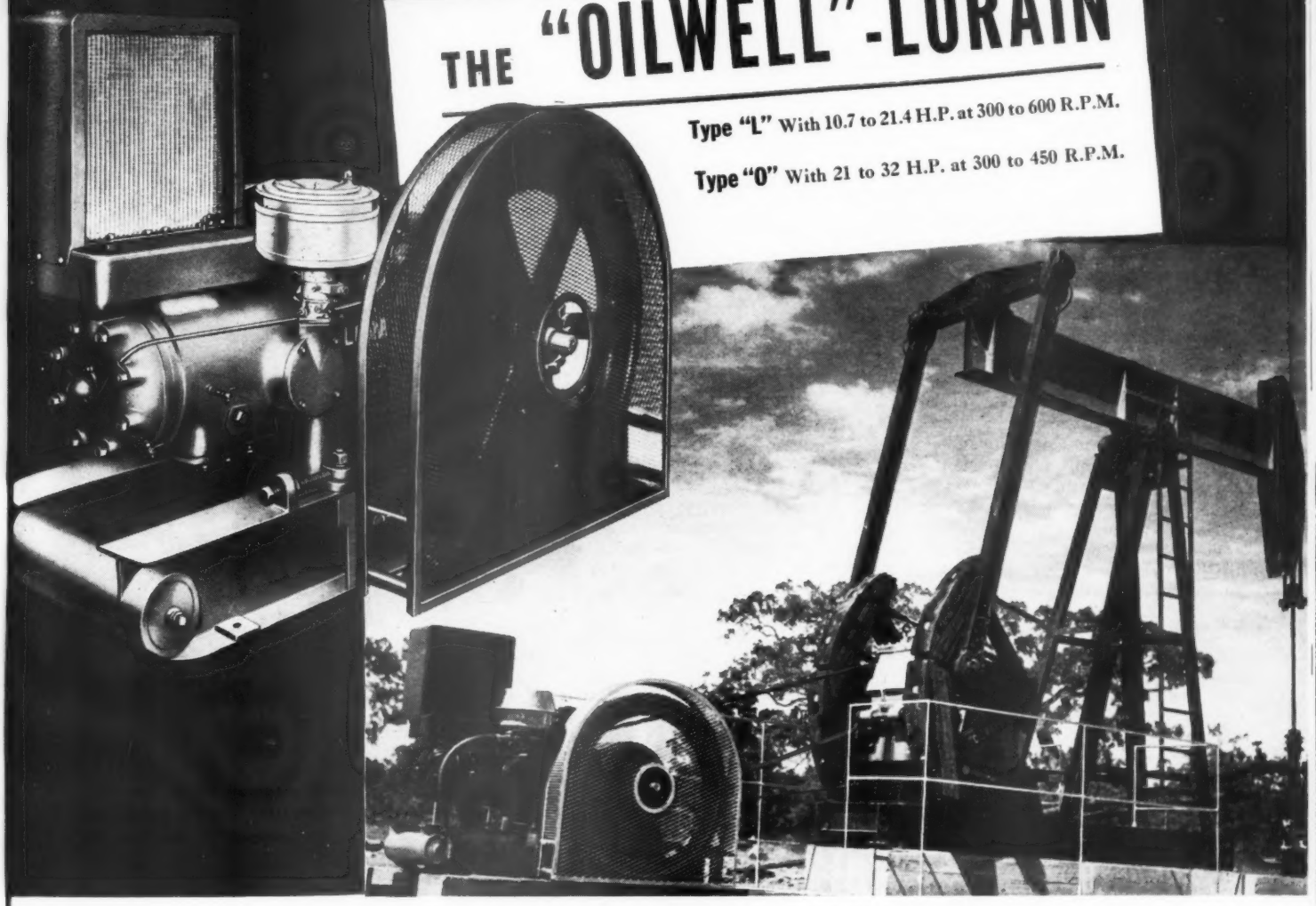

THE "Oilwell"-Lorain Type "L" and Type "O" Engines are sturdy single-cylinder, two-cycle power units built to withstand hard continuous service and to require a minimum of attention. The overall design of these Engines is such that the number of working parts has been reduced to a minimum and the wearing parts are designed according to stationary-engine standards.

Condenser-type cooling system, large-capacity oil reservoir, and a combination forced-feed and oilbath lubrication system contribute to trouble-free operation. Enclosed disc-type clutch permits the use of standard V-belt sheaves. Control and service points are readily accessible. Large hand holes are provided at the crank end and adjacent to the crosshead.

The "Oilwell"-Lorain Type "L" and Type "O" Engines are adaptable to a wide range of oil-field applications since they are compact and weatherproof, and can be equipped to operate on either natural gas, butane or diesel fuel. A minimum of conversion parts permits easy and economical adaptation to a change in operating conditions without a reduction of horsepower.

SPECIFICATIONS

"Oilwell"-Lorain Engine	Type "L"	Type "O"
Bore ..... inches	7½	9½
Stroke ..... inches	8	10
Rating: At 300 r.p.m. ..... horsepower	10.7	21
At 450 r.p.m. ..... horsepower	—	32
At 600 r.p.m. ..... horsepower	21.4	—
Displacement ..... cubic inches	353	710
Rated Brake Mean Effective Pressure ..... p.s.i.	40	40
Diameter of Crank Pin ..... inches	4¾	5
Overall Height ..... inches	52⅞	59½
Overall Width ..... inches	47¼	57⅞
Overall Length ..... inches	70	87¾
Overall Length of Structural-Steel Skid Base Accessory ..... inches	72	96
Exhaust Connection (Pipe Size) ..... inches	4	4
Oil Capacity ..... quarts	19	25
Water Capacity ..... quarts	14	21
Shipping Weight: *Standard Equipment Only*:		
Domestic ..... pounds	2423	3700
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Complete with Steel Skid Base and Guard:		
Domestic ..... pounds	2916	4500
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lubricator cap removed. The pumps are stopped when the lubricator is full and all of the air is out of the lines.

Then, the primary plug is dropped into the lubricator, the head valve is closed, the lubricator cap is screwed in place, and the cementing pumps are started. About 600 psig pump pressure is required to shear the screws holding the float valve assembly. As soon as this occurs, the head valve is opened, and the valves on the cementing lines to the flow cross are closed. This forces the primary cementing plug down through the head valve and into the casing ahead of the cement slurry that follows it.

After the primary plug is on its way down, the valves on the cementing lines to the flow cross may be opened, and the head valve may be shut without shutting down the cementing pumps. Other plugs that will pass through the shoe may be placed in the stream of cement slurry at any time during the operation without shutting down the pumps by dropping them in the lubricator and manipulating the valves.

The top plug with its back pressure valve is lubricated into the casing on top of the cement and ahead of the drilling fluid or water that is used to pump it down to the stall collar. Fig. 2 shows the float valve assembly and the trip ball in the bottom of the hole as the primary plug and the top plug are being pumped down with cement slurry between them.

Fig. 3 shows the top plug seated in the venturi of the stall collar as the cementing operation is completed. Figs. 4, 5, and 6 show the float shoe, cementing plug, and stall collar assemblies in detail. All materials used in these assemblies is drillable.

The cementing plugs are made oversize for the ID of the casing in which they are used. As may be noted in the illustrations, they have a hollow bore with a cork in the bottom. The bore is filled with water and the cork inserted before the plugs are placed in the lubricator section of the cementing head.

The cork is ejected downward and the oversize plug is squeezed down from the cementing head into the casing. The natural reforming action of the rubber materials of which the plugs are made causes them to retain their shape as they are pumped downward through the casing.

A cup effect is obtained on the lower sealing member of the plug for "down" swab action. The upper sealing member contains bypass openings for "pressured balance" above and below the top flanging seal. This is designed to prevent the plug from wobbling as it is pumped down. These bypass holes also provide passageways for the input pressure to reach the top sealing lips of the lower sealing member.

As soon as the top plug has been pumped down and locked in the stall collar, the piston-like back pressure valve in the top of it will close as pressure is taken off the cementing head. The cementing head may then be removed and the casinghead can be equipped for completion of the well.

The full bore discharge from the casing into the well bore is designed to reduce the working pressure on the cementing pumps as the slurry is placed behind the casing. It is also thought that the slurry may be placed more rapidly and have less opportunity for channeling upward behind the casing.

The use of a bottom and top plug is intended to prevent contamination of the slurry with the mud or fluid below it in the casing. It is conceivable that cement slurry weighing several pounds per gallon more than the fluid in the casing below it might drop down through the fluid and tend to mix with it before the slurry leaves the casing shoe, unless it is separated by a primary (or bottom) plug.

Contamination of the slurry in its upward course behind the casing is about as impossible to control as it is to measure. The slurry either sets up as a successful cement job or it fails. Contamination of the slurry behind the casing is a problem being worked on with centralizers, scratchers, manipulation, and rotation of the casing, preliminary wash treatments, etc. The answers, however, are usually hidden.

The use of the cementing head with its cementing plug lubricator is designed to enable the operator to inject the plugs into the flow stream without shutting down the pumps and without letting air in the stream that might cause bubbles in the cement. ★ ★ ★

FIGS. 4, 5, and 6

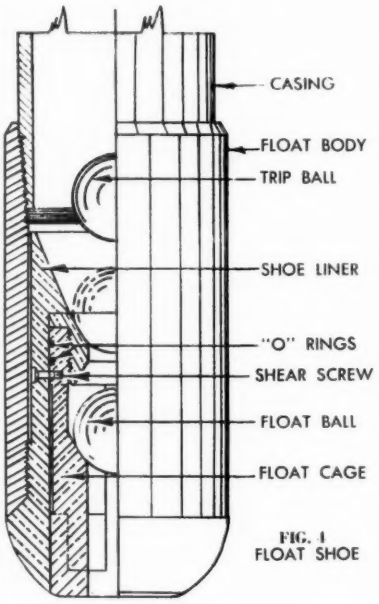


FIG. 4
FLOAT SHOE

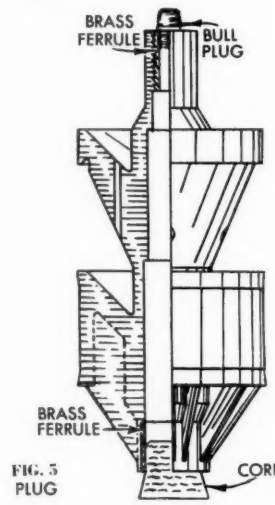


FIG. 5
PLUG

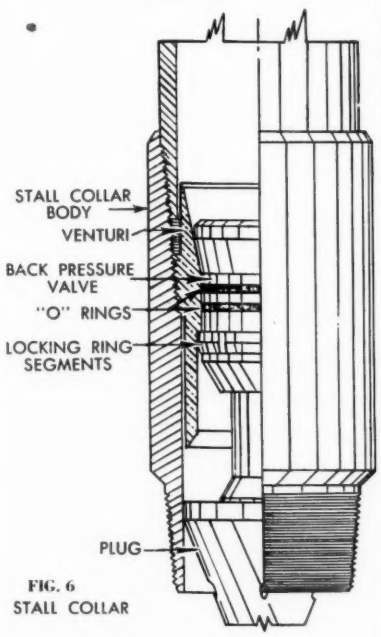
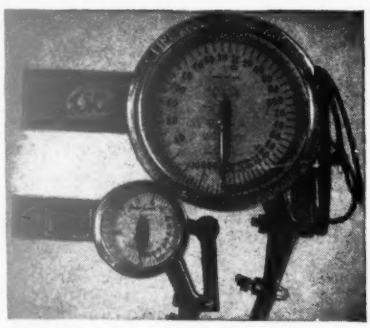


FIG. 6
STALL COLLAR

LINE SCALES



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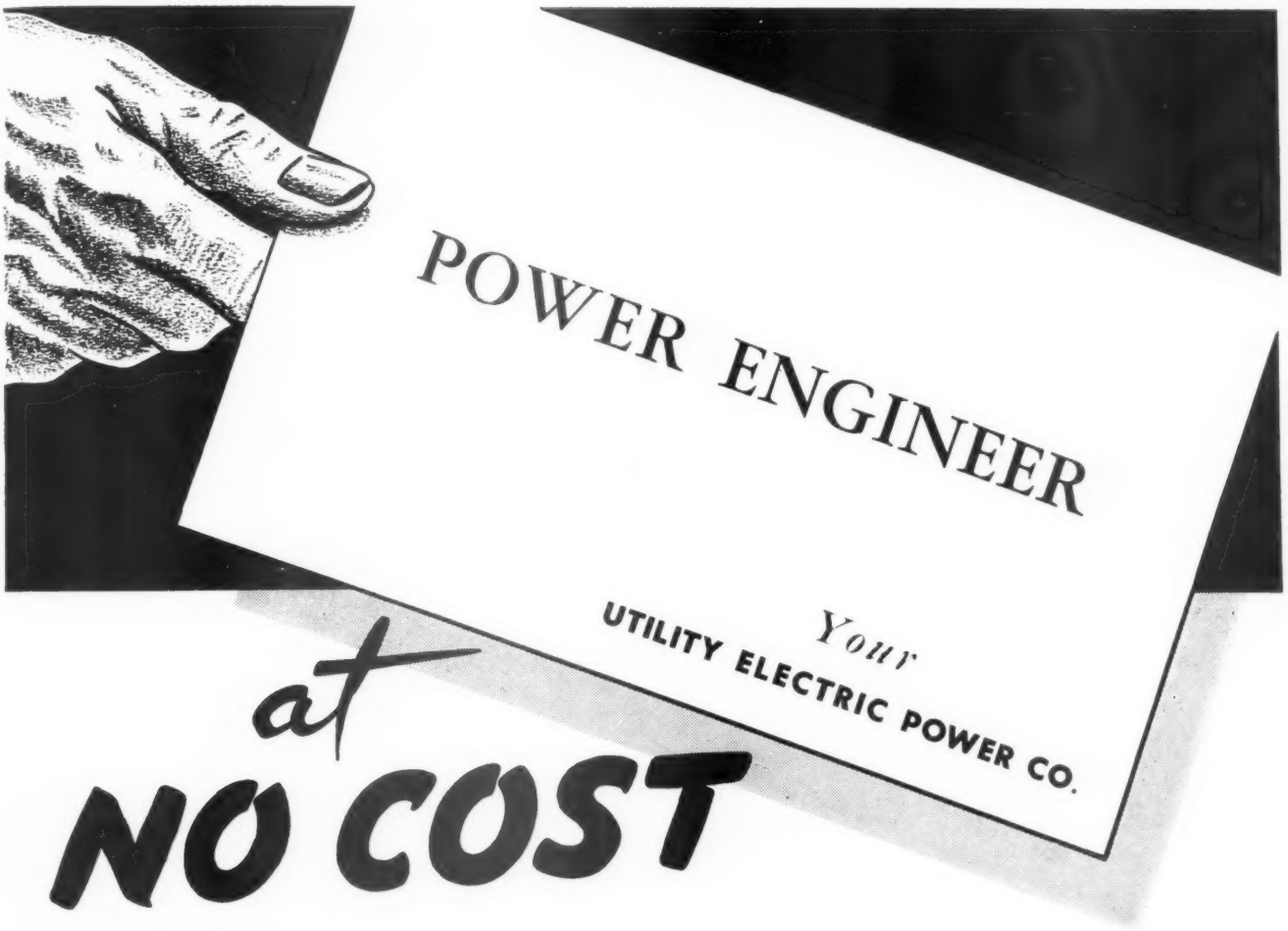

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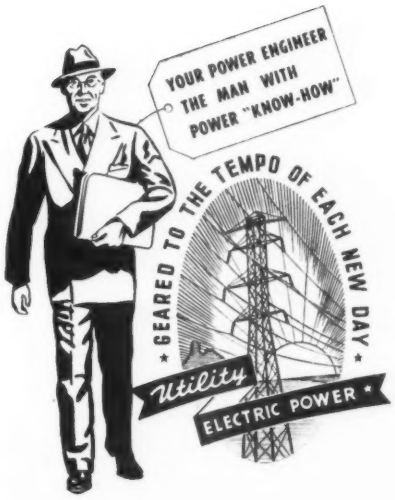

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Slick-Urschel finds deepest Ellenburger production

Slick-Urschel Oil Company of San Antonio releases the following information of interest to the industry regarding its Ellenburger discovery well located near the Upton-Reagan County, Texas, lines about nine miles north of the Big Lake field. This well, known as the Alford No. 1, was drilled to a depth of 10,384 ft by the Plymouth Oil Company in 1941. Seven-inch casing was set to 9748 ft. Due to mechanical difficulties, the well was temporarily abandoned. Fred Turner, of Midland, Texas, in 1947 obtained a farm-out from the Plymouth of a half interest in the well with 4000 acres of full interest leases in return for completing the well to the Ellenburger, with the Plymouth reserving a similar amount of acreage. Slick-Urschel Oil Company subsequently took over the deal with Fred Turner retaining an override. The acreage is located in a block of approximately 8500 acres of leases on a structural high in the basin, which shows as a large structure from seismograph, surface, and sub-surface indications.

Slick-Urschel Oil Company began operations in the Alford in early June and drilled a directional whipstock hole through the 7-in. casing at 8500 ft and continued to a total depth of 12,022 ft.

Heavy gas pressure was encountered in the Pennsylvanian section where a drillstem test was taken at 9410 to 9494 ft, recovering 6000 ft of pipe line oil in 4 hr.

The gas pressure in the Pennsylvanian, combined with the problems of a section of heaving shale that caused difficulties in the earlier well, and combined with the porosity of the Devonian section resulted in a serious mud problem, but by carefully balancing the requirements of these three difficult conditions, Jim Hewgley of Tulsa, a partner in the operation and production supervisor, was able to complete the hole and, in his opinion, with the proper casing and mud engineering program in future wells, these problems will not be difficult to overcome.

The Devonian was topped at 10,010 ft and the Silurian section at 10,600 ft. No drillstem tests were taken in these sections but the sample cuttings indicate promising shows. Other indications of shallower producing horizons were logged during the earlier Plymouth operation.

The Ellenburger lime was topped at 11,020 ft and has been penetrated to 12,022 ft. Cutting analyses throughout this thousand feet of section showed oil and gas saturation and fluorescence. Fifteen drillstem tests were taken of which 11 were successful, showing oil and gas. Three drillstem tests were mechanical failures and a fourth had no recovery.

A full string of 5-in. OD extreme line casing was run and cemented to bottom. The casing was perforated from 11,885 to 11,910 ft, 11,945 to 11,960 ft, and 11,975 to 11,985 ft, with the bottom of the hole also open. Subsequently, the well was acidized with 1500 gal of acid. Correlations with the Big Lake field indicate that there are several hundred more feet of Ellenburger to be drilled, which, since the cuttings from the bottom of the hole show good staining and saturation, may also prove productive.

On a potential test the well flowed at the rate of 888 bbl a day on a $\frac{3}{8}$-in. tubing choke with a gas-oil ratio of 4000 to 1, tubing pressure 1850 psi, and casing pressure 2400 psi.

The Railroad Commission has granted a temporary allowable of 500 bbl a day.

Operators are moving in two rigs at the present time and locations are being staked for four to six locations ahead.

This discovery is of especial interest, for it is the first Ellenburger production in the basin, is the deepest Ellenburger production in West Texas, and the indicated oil and gas section is considerably thicker than in any previous Ellenburger well. ★ ★ ★

Belt creep is excusable

By W. F. SCHAPHORST

Belt creep cannot be prevented. Why? Because belt creep is due entirely to the elasticity of the belting material. As all belting materials are elastic, all belts creep. Even belts made of steel are bound to creep, because steel is elastic. The more elastic the material of which the belting is made, the greater the creep.

I will endeavor to explain why a belt creeps. On the upper or slack side of a horizontal belt drive, let us take a portion of the belt 1 in. long. This 1 in. moves toward the left, say, as the belt runs around the pulleys. As soon as it comes in contact with the driven pulley, which is at the left, it is acted upon by a slight force due to the tension created by the driver pulley. As this 1-in. portion moves downward, the pull becomes greater and greater and when it leaves the driven pulley at the bottom, the pull or tension has attained its maximum value. Instead of being 1 in. long, however, its length has been increased by the value of "x." Just what this amount "x" is, depends upon the elasticity of the material and the intensity of the pull on the tight side.

It is this gradual readjustment from a length of 1 in. to a length of 1 in. plus "x" that causes the belt to "creep." Hence we have a shortened belt running onto the driven pulley and a lengthened belt running onto the driver pulley. On thinking it over, it becomes evident that it is impossible for such a condition to exist without a readjustment somewhere and that readjustment occurs in the form of creep.

Power is lost due to creep because it represents that much friction. Wherever there is friction, there is power loss, of course. The amount of power loss is easily determined when the percentage of creep is known. For example, if the creep is 1 per cent, the power lost due to creep is 1 per cent; if the creep is 1½ per cent, the power lost due to creep is 1½ per cent; if the creep is 2 per cent, the power lost due to creep is 2 per cent, etc. In other words, the power loss is proportional to and identical with the percentages of creep.

It is common practice to allow 1½ to 2 per cent for creep. Creep can be computed with considerable accuracy, but the computation involves the use of the so-called modulus of elasticity of the material and the stress or acting force in pounds per square inch. As the values cannot be determined without special and rather delicate instruments, the values 1½ to 2 per cent are generally taken for granted.

Slackness or tightness of a belt has almost no influence on the creep. The elasticity of a belt is approximately the same at high tension as it is at low tension, in which case the creep is the same regardless of whether the belt is pulled up tight or whether it is permitted to run slack. In general, the slack belt is preferable, because of the smaller tension on the belt, the reduced pressure on the bearings, and the greater arc of contact of the belt on the pulleys. If the material is less elastic at low tension than at high tension—as is most often the case—the slack drive is all the more preferable.

In purchasing belts and laying out belt drives it is always good practice to make allowance for creep because creep is inevitable and cannot be prevented. Slip, however, *can* be prevented. Slip is inexcusable. ★ ★ ★

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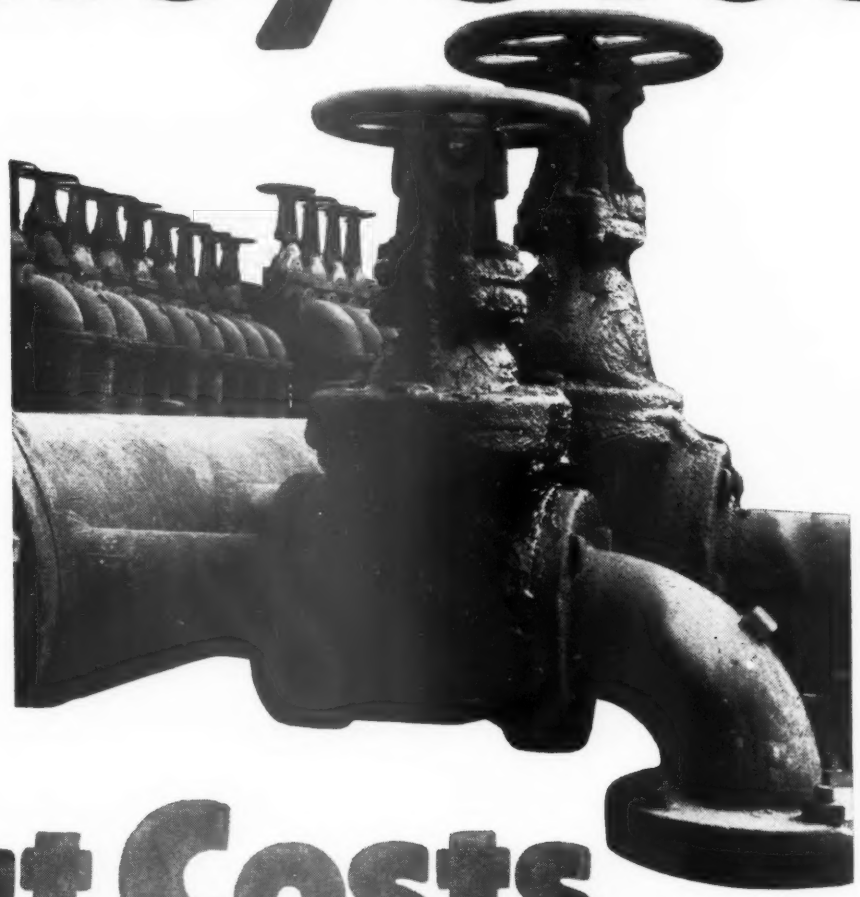

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TCC processing of Pennsylvania oil fractions*

By H. D. NOLL and D. M. LUNTZ, Houdry Process Corporation

In view of the difficulty experienced by Pennsylvania refiners in meeting competitive gasoline octane numbers with the presently practiced thermal cracking processes, a study has been made to show how catalytic cracking, as typified by the TCC process[1, 2], may be used by the refiner of Pennsylvania grade crude oil to increase both quality and quantity of overall refinery gasoline. This paper presents the results of the study and compares the gasoline yields and octane numbers to be realized from several different methods of thermal and catalytic processing Pennsylvania light crude oil fractions.

The Pennsylvania crude taken as the basis contains 25 per cent light straight run gasoline, 10 per cent heavy naphtha, and 20 per cent light gas oil, giving a total of 55 per cent of the crude available for processing for gasoline production. The study reported herein is applied only to the aforementioned fractions boiling outside the lubricating oil range. Inspections of these light crude fractions are given in Table I.

Typical data for TCC cracking of the light gas oil and the proportionate blend of gas oil and heavy naphtha are presented in Table 2. In connection with these data, it should be borne in mind that they are shown for illustrative purposes only and are not to be taken as limiting from any point of view. For example, if the gasoline end point is reduced when cracking the gas oil-naphtha blend then the octane number will be higher (because of less unconverted virgin material present in the gasoline) and the yield will be lower.

TCC cracking permits the production of gasoline having considerably higher CFR-R and CFR-M octane numbers than does thermal processing. At the same time, the yield of catalytic gasoline is higher and the volatility is improved. This improved volatility should be particularly advantageous in blending to make premium motor fuel.

The following table compares TCC with estimated thermal cracking of the Pennsylvania gas oil.

Yields—per cent vol. on fresh charge:	TCC cracking	Thermal cracking
10-lb RVP gasoline	72.3	71.0
Excess C_4	19.3	6.0
Fuel oil	2.0(35°API)	14.0(8°API)
Fuel gas (FOE)	10.3	15.6
10-lb RVP gasoline inspections:		
CFR-M clear	79.3	68.0
CFR-M, 3 cc TEL	88.1	78.0
CFR-R, clear	89.4	74.0
CFR-R, 3 cc TEL	99.7	86.0
ASTM 50 per cent point—°F	196	255

As more C_3H_6 and C_4H_8 are produced in TCC than in thermal cracking, the addition of catalytic polymerization increases the yield and octane advantages of TCC over thermal processing.

In order to evaluate the differences between thermal and catalytic cracking, gasoline yield-octane relationships have been projected for the four different refinery process schemes outlined in Table 3. Method I is representative of present thermal operations, whereas methods II, III, and IV show the effects of combining TCC catalytic cracking and thermal reforming in different ways. As a new TCC installation usually may be accomplished by the addition of only a new reactor-kiln section (plus compressors to handle the wet gas) to the existing fractionator and heaters, it is entirely practical, in a properly designed unit, to perform blocked-out TCC cracking and thermal reforming in the same installation.

Two charts were constructed to show comparative gasoline yields and octane numbers to be realized with the various methods. Fig. 1 gives the comparison on the basis of CFR-R octane numbers, and Fig. 2 on the basis of CFR-M octane numbers.

Referring to these two charts, it may be seen that the highest yield of a given CFR-R or CFR-M octane number gasoline is obtainable with the scheme having the greatest proportion of catalytic cracking (Method IV), whereas the lowest yield is that with all thermal processing (Method I) with the other two methods intermediate. Data read directly from Figs. 1 and 2 and illustrating this point are shown in the following tables.

1. Comparison on basis of CFR-R octane numbers:

Processing method number	I	II	III	IV
Vol. per cent 10-lb RVP gasoline	80.5	87.4	85.3	89.9
CFR-R, clear	72.0	72.0	72.0	72.0
cc TEL to 84 CFR-R	2.8	2.0	2.5	1.8

*Paper read before National Petroleum Association meetings in Bradford and Oil City, Pennsylvania.

FIG. 1. CFR-R octane number and lead response vs gasoline yield for various methods of processing Pennsylvania light crude fractions.

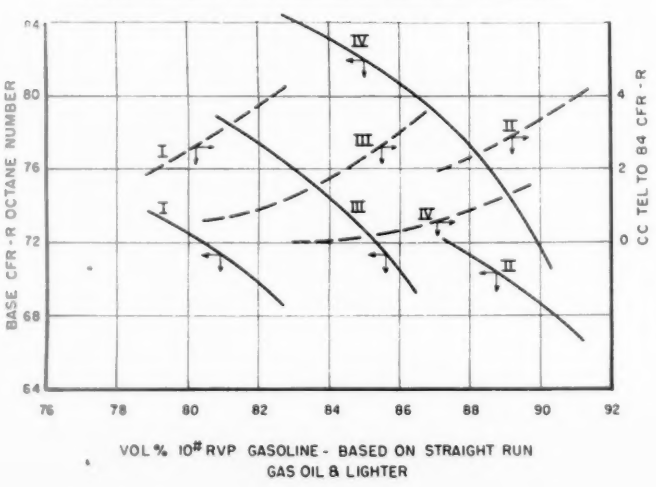
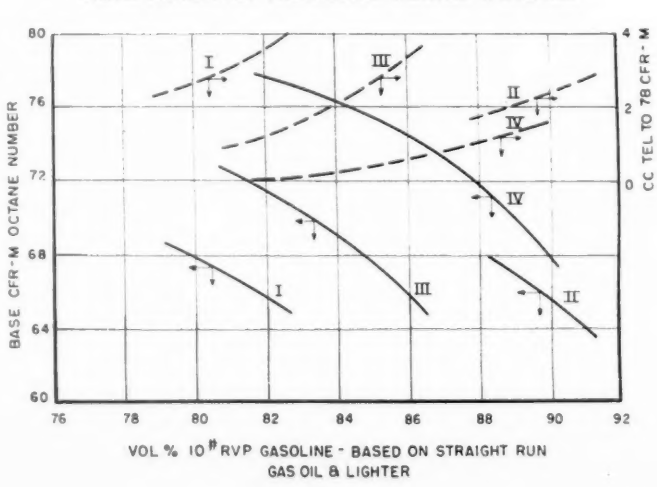

NOTE: NUMBER OF PROCESSING METHOD INDICATED
BASE CFR-R OCTANE NUMBER
CC TEL TO 84 CFR-R
VOL % 10# RVP GASOLINE - BASED ON STRAIGHT RUN GAS OIL & LIGHTER

FIG. 2. CFR-M octane number and lead response vs gasoline yield for various methods of processing Pennsylvania light crude fractions.


NOTE: NUMBER OF PROCESSING METHOD INDICATED
BASE CFR-M OCTANE NUMBER
CC TEL TO 78 CFR-M
VOL % 10# RVP GASOLINE - BASED ON STRAIGHT RUN GAS OIL & LIGHTER

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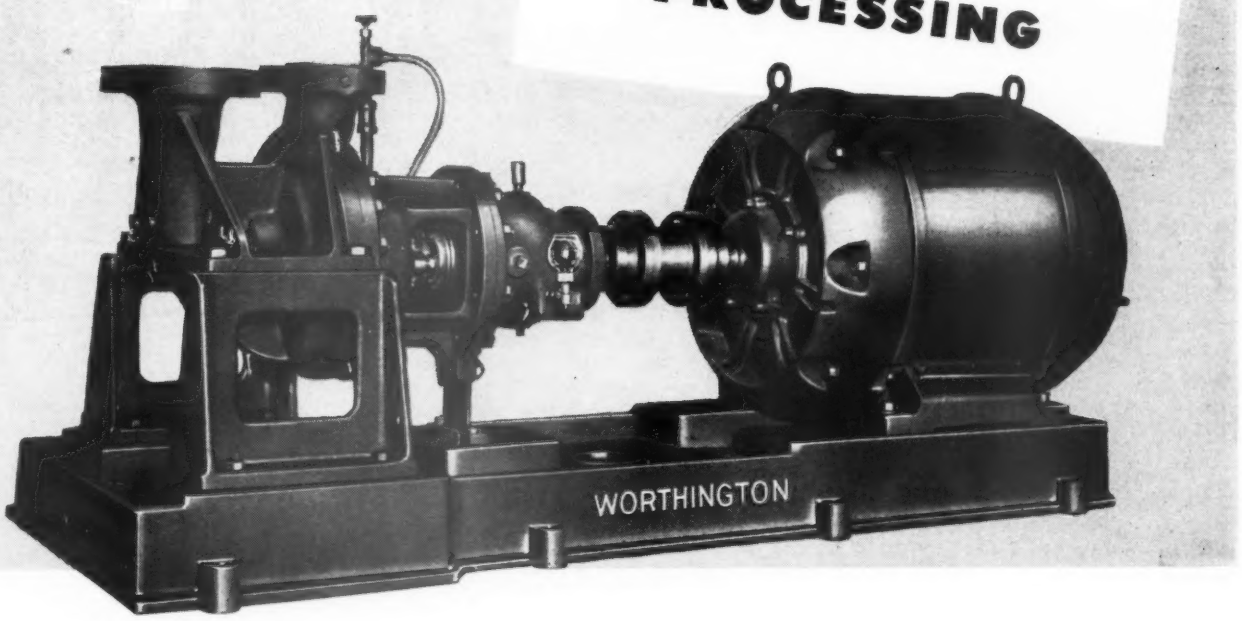

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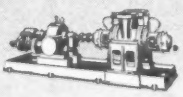

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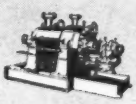

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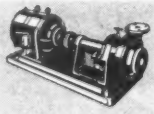


Type HL. Several construction arrangements permit flexibility in application. Designed for temperatures up to 225°F., or higher with water-jacketed stuffing box. Capacities up to 1600 g.p.m., heads to 500 ft.

TABLE 1. Inspections of typical Pennsylvania crude oil fractions.

Fraction	Light straight run gasoline	Straight run heavy naphtha	Light straight run gas oil	Gas oil-heavy naphtha blend (⅔ G.O. ⅓ H.N.)
Per cent on crude	25	10	20	30
Inspections:				
Gravity—°API	68.3	49.4	40.4	44.5
ASTM distillation:				
IBP—°F	94	294	480	308
10 per cent—°F	140	351	508	382
30 per cent—°F	187	368	525	418
50 per cent—°F	219	379	542	463
70 per cent—°F	246	393	564	525
90 per cent—°F	292	414	593	578
E.P.—°F	349	443	632	616
RVP, psi	12.9	..	..	..
Octane number CFR-M, clear	58.7	5.0	..	..
Octane number CFR-M 3 cc TEL	77.1	40.1	..	..
Octane number CFR-R clear	56.8	..	..	..
Octane number CFR-R 3 cc TEL	78.2	..	..	..
Aniline point °F	..	152	179	166
SU viscosity at 100°F—seconds	..	..	38.7	33.1

2. Comparison on basis of CFR-M octane numbers:

Processing method number	I	II	III	IV
Vol. per cent 10-lb RVP gasoline	79.9	88.3	84.7	90.0
CFR-M, clear	68.0	68.0	68.0	68.0
cc TEL to 78 CFR-M	2.7	1.8	2.5	1.6

The higher yield for Method II than for Method III is a reflection of the fact that a total straight run gasoline is usually a poorer reforming charge stock than is the corresponding heavy naphtha.

The maximum CFR-R or CFR-M octane number that may be obtained is highest with the greatest proportion of catalytic cracking and lowest for all thermal processing. Further, a greater CFR-R - CFR-M spread and a higher gasoline yield for any given octane number are realized with the greater proportion of catalytic cracking. These points are illustrated by the data of the following table, which give the maximum CFR-R and CFR-M octane numbers and corresponding yields estimated as obtainable (without under-cutting of gasoline end point) when processing according to the several schemes.

Processing method number	I	II	III	IV
Maximum CFR-R Octane no. (3 cc TEL)	85	85	90	97
Maximum CFR-M Octane no. (3 cc TEL)	79	80	82	88
Vol. per cent 10-lb RVP gasoline	80	89	81	77

TABLE 2. Typical data for TCC cracking of Pennsylvania crude oil fractions.

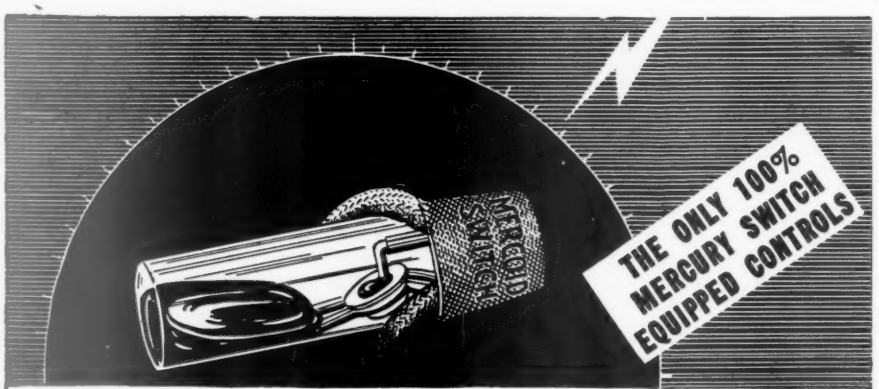
Charge stock	Gas oil	Gas oil-heavy naphtha blend
Yields from TCC cracking only:		
10-lb RVP gasoline, % vol.	72.3	64.9
Excess C_4, % vol.	19.3	16.7
Cycle stock, % vol.	2.0	11.8
Liquid recovery (C_4 and heavier), % vol.	93.6	93.4
Dry gas (C_3 and lighter), % wt.	10.4	10.7
Coke, % wt.	10.1	6.5
C_4H_8, % vol.	7.6	9.1
C_3H_6, % vol.	6.5	8.1
Yields from TCC cracking plus catalytic polymerization (70 per cent C_3 recovery, 90 per cent C_4 recovery):		
10-lb RVP gasoline, % vol.	81.3	76.0
Excess C_4, % vol.	10.2	6.3
Cycle stock, % vol.	2.0	11.8
Liquid recovery (C_4 and heavier), % vol.	95.4	95.8
Dry gas, % wt.	9.2	8.6
Coke, % wt.	10.1	6.5

Inspections of 10-lb RVP gasolines:

	TCC crkg.	TCC crkg. +cat. poly.	TCC crkg.	TCC crkg. +cat. poly.
Octane number—CFR-M, clear	79.3	81.0	75.5	78.3
Octane number—CFR-M, 3 cc TEL	88.1	89.2	84.7	86.8
Octane number—CFR-R, clear	89.4	91.1	82.9	86.0
Oeatne number—CFR-R, 3cc TEL	99.7	>100	94.7	96.2
ASTM 90 per cent Point—°F	360		335	

TABLE 3. Outline of processing methods.

Processing method number	I	II	III	IV
Charge stock compostion, per cent volume				
Pennsylvania light straight run gasoline	45.5	45.5	45.5	45.5
Pennsylvania heavy straight run naphtha	18.2	18.2	18.2	18.2
Pennsylvania light straight run gas oil	36.3	36.3	36.3	36.3
Total	100.0	100.0	100.0	100.0
Processing:				
Thermal reforming of				
Light straight run gasoline				Yes
Heavy straight run naphtha		Yes		
Total straight run gasoline	Yes		Yes	
Thermal cracking of:				
Light straight run gas oil	Yes			
TCC catalytic cracking of:				
Light straight run gas oil		Yes	Yes	
Light straight run gas oil+ heavy naphtha				Yes
Gas recovery	Yes	Yes	Yes	Yes
Per cent C_3 recovery	70	70	70	70
Per cent C_4 recovery	90	90	90	90
Catalytic polymerization	Yes	Yes	Yes	Yes
Distribution of charge stocks to cracking, per cent:				
Thermal:				
Gas oil	36.3	..	..	..
Naphtha	63.7	18.2	63.7	0–45.5
Catalytic:				
Gas oil	..	36.3	36.3	54.5
Naphtha	..	..	..	



IT HAS THE ENDURANCE OF PROVIDING

MILLIONS

OF "MAKES" AND "BREAKS" IN THE ELECTRICAL CIRCUIT

The mission of a Mercoid Mercury Switch in an automatic control is to assure longer life and greater dependability—minimizing the need for attention after the control is in service. Mercoid Controls lend themselves to quick installation and adjustment, all of which are invaluable contributions in a time of national crisis.

Mercoid Switches, the distinguishing feature, used exclusively in all Mercoid Controls, are especially designed types of hermetically sealed mercury switches. They are not affected by dust, dirt, moisture or corrosive gases, nor are they subject to open arcing, oxidation, pitting or sticking of contacts—common causes of trouble.

Keep these important facts in mind when selecting automatic controls.

MERCOID CONTROLS

FOR HEATING, AIR CONDITIONING, REFRIGERATION, AND INDUSTRIAL APPLICATIONS

THE MERCOID CORPORATION, 4205 BELMONT AVE. CHICAGO 41, ILL.

In this study, no attempt has been made to consider the economics of installing catalytic cracking facilities such as outlined herein; however, the real criterion is not economics but the fact that future octane levels will make it impossible to produce motor gasoline of competitive quality without catalytic cracking and TCC catalytic cracking is an answer to the octane problem.

Bibliography

1. Noll, Bergstrom, and Holdom; "New Integral T.C.C. Unit Makes Catalytic Cracking Available to Small Refiners", *Oil and Gas Journal*, April 6, 1946.
2. Kelso, Peavy, Myers, and Hoge; "Design and Operation of a Small-Scale Thermofor Catalytic Cracking Unit", *Petroleum Refiner*, August, 1947.

★★★

new and improved machinery and equipment

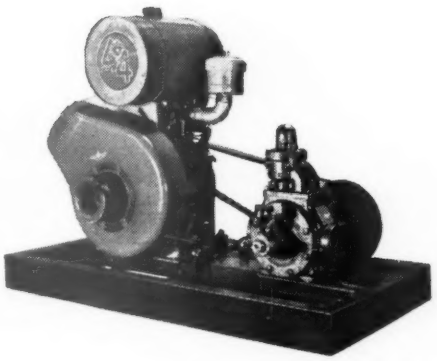
A REGULAR FEATURE
appearing in
THE *Petroleum* **Engineer**
Irwin-Keasler Building
Dallas 1, Texas

NEW EQUIPMENT

(1) Tank bottom circulator

The Southwest Equipment Company has announced a new pump unit designed for the special job of circulating tank bottoms. Field tests show that this unit will reduce the length of time required to treat tank bottoms, reduce the amount of treating chemical required, and the amount of heat necessary to treat the oil. The oil and basic sediment are passed through the pump with a minimum of turbulence and velocity, preventing the formation of tighter emulsions that are ordinarily generated when whipped at high speed through centrifugal pumps or passed at high velocity through worn gears of geared pumps or valves of piston pattern pumps.

The standard unit, Model BE-20, comprises a bucket type rotary pump, with self-adjusting buckets that automatically compensate for wear, mounted on a welded structural steel base 20 in. wide by 34 in. long and V-belted to a 4.4-hp, 4-cycle, air-cooled engine. It handles 27 bbl per hr at 90 psi maximum pressure.



The pump rotates at the relatively low speed of 575 rpm and each of the four buckets in the rotor really "shovels" a "slug" of oil from the intake, across the pump to the discharge at low velocity and with very little turbulence or slippage.

All wearing parts of the pump can be quickly and inexpensively replaced in the field without need of special tools or skilled mechanics and without disconnecting the piping. Other pump units of same general construction, using either engine or electric motor drive, are available up to 750 gpm. This pump design is particularly desirable for the transfer of all types of high viscosity oils at temperatures up to 600 F.

The standard BE-20 unit will be sold through oilfield supply houses and are available for prompt delivery.

(2) Mono-Weld radiator

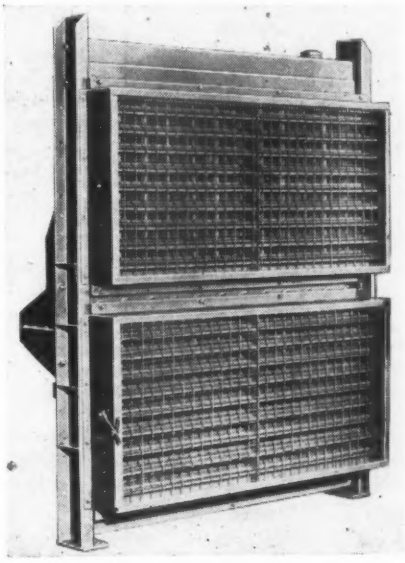
The Young Radiator Company announces the development of a new type radiator known as the "Mono-Weld", used for heavy-duty gasoline, gas, and diesel engine applications.

Using the latest electric welding methods, the new Young Mono-Weld type radiator is stronger and more efficient than its sturdy predecessors, the manufacturer states. The Mono-Weld is an outgrowth of a wartime demand by the Navy for a heavy radiator tank that would stand the terrific shock of gun recoil. Ordinary radiator tanks, made of cast-iron, had a tendency to crack under such heavy use. At this point, Young engineers pioneered the welded-steel tank, to meet the Navy's rigid requirements.

The new Mono-Weld line covers a complete range of sizes from the smaller units, approximately 2½ ft square, in graduated sizes up to the larger units, approximately 10½ ft square.

Innovations of this line as exemplified by one of the larger radiators, approximately 7 ft wide and 9 ft high, has fabricated steel-headers, formed steel side members, and seamless tubes brazed to heavy header plates. This Young Mono-Weld radiator has 24 cooling sections, any of which can be removed for repair or replacement in a matter of minutes. Extremely important to the operation of this type unit is the special, aerodynamically-designed fan with variable pitch that can be adjusted for temperature and climatic changes. Either a pusher or puller fan can be used, sucking the air in or blowing it out of the core, as the particular installation may require. Heavy steel formed and welded shutters are used to insure better control of the cooling process.

The entire unit is mounted on steel feet, welded to the side members, which in turn are fitted with steps so that an operator can get at the top of the radiator for inspection and filling.



(3) Rope socket

A new type "Quick-Change" rope socket that eliminates all line loss has been introduced by the Cavins Company.

This tool also does away with the necessity of babbitting a rope socket to the sand line at the start of each job, according to the manufacturer.

Simple in construction, tion, it consists of a body, a cap, two liners, and a sturdy tapered pocket thimble, is designed to fit all sizes of the "Quick-Change" sockets and is permanently babbitted to the line in the conventional "fish hook" manner of securing rope ends.

In working assembly, the liners enclose the thimble and lock around the lifting neck of the body. Slanted shoulders on exterior of the liners and the interior of the cap provide added retaining safety.

Breakdown tests performed by a recognized standards laboratory resulted in a pull of 13,300 lb to separate the sand line from the thimble.

Although manufactured in a variety of standard sizes from 1¾ in. OD to 2¾ in. OD, other sizes may be ordered by specification.

(4) New electrode

The Lincoln Electric Company announces a new electrode, Toolweld A & O, for hard surfacing tools and dies. The new electrode is designed to simplify procedures and reduce the cost of depositing surfaces of weld metal of tool steel quality.

Toolweld A & O, ("A" for air-quench; "O" for oil-quench) is for use in building up the working surfaces or edges of cold-working metal cutting and forming tools. It will produce surfaces of high strength for resisting wear and impact in all applications where high temperatures are not encountered. When deposited on either ordinary carbon steel or on any one of the hundreds of alloy steels, Toolweld A & O produces a surface whose properties will match those of the best tool and die steels, the manufacturer states.

The deposited weld metal is of the 5 per cent chrome type and may either be used as welded or subjected to a wide range of heat treatments. When used on ordinary steel, the weldment may be heat treated to give the maximum hardness quality in the weld. When used on tool steel, the weldment may be heat treated as is demanded by the nature of the base material.

Toolweld A & O is a versatile, low-cost electrode recommended for the economical manufacture of composite metal working tools by using a carbon steel base and building up edges of tool steel quality, or for the alteration or repair of hardened dies and tools. Successful applications can be made on such tools as blanking dies, forming dies, die casting dies, upsetter dies and punches, forming rolls, burnishing tools, centerless grinder rests, planer ways, flash shearing dies, and punches.

The electrode will operate on either alternating or direct current, electrode negative with d.c. It will deposit a thick bead in one pass in the low current portion of the operating range, and a thin bead in the high current portion of the range. Thin beads are smooth and flat, requiring a minimum of grinding.

(5) Bridging plug

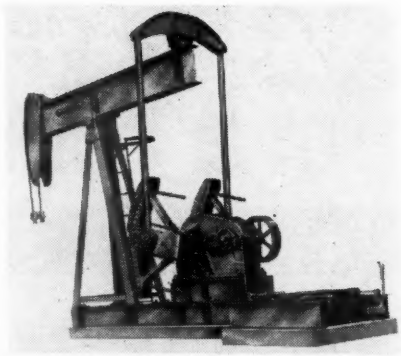
A new bridging plug is being made by International Cementers, Inc. The object behind the invention was to develop a bridging plug that could be set easily and could be drilled easily and would be inexpensive. The tool is effective as a simple bridging device or as a "heaving plug" and is not intended to withstand high differential pressure, it is stated. When the bridge plug is used as a bridge on which to place sand, the sand will do the work of withstanding these greater pressure differentials when the higher differential pressures are to be encountered.

The alloy of aluminum from which this plug is made is very brittle and the plug is made of a number of small component parts; therefore, the plug can be easily drilled with a chisel bottom bailer or other tools.

The plug can be run on the operator's sand line or tubing or on equipment supplied as part of the service company's facilities. It may be used with or without leather cups or rubber disks. It is supplied in the nominal sizes from 4½ in. to 10¾ in.

(6) Twin-crank pumping unit

A new model API twin-crank pumping unit offers 15 improvements designed to give economical pumping through more service with less servicing. Frames and sampson posts are electric welded. Frames are rigidly braced and have extensions that can be easily bolted on to take various types of prime movers including engines that have no sub-base. Walking beams are carried on widely spaced saddles equipped with needle bearings. Beam can easily be adjusted toward and away from well center by means of set screws. Hangers have true arc, which provides straight polished-rod travel. Hangers are easily removable for well servicing without disturbing the rest of the unit. Equalizer is equipped with needle bearings, which are lubricated through a tube from an easily accessible point at top of safety ladder. Equalizer allows rotation in two planes, giving positive self-alignment between the two pitmans. Pitmans are designed so that bolts are not carrying the pitman load.



Safety features include band type brake with remote control lever, sampson post ladder with safety loop, and generous safety factors engineered into the unit. The speed reducer is designed to API specifications and includes nine improved features for longer life and smooth operation.

American Manufacturing Company of Texas is the manufacturer.

(7) Air-cooled engine

Kept closely "under cover" for the last three years, the latest addition to the line of Wisconsin heavy-duty air-cooled engines now emerges and makes its official bow to the power equipment industry. It is a two-cylinder job, supplied in two models, designated as "Models TE" and "TF". These engines round out a complete line of 4-cycle air-cooled engines, from 2 to 30 hp, now available in single cylinder, two-cylinder, and V-type four-cylinder types.

The new engines embody the same basic heavy-duty design and construction features that are characteristic of all Wisconsin air-cooled engines—such as Timken tapered roller bearings at both ends of the dynamically balanced drop-forged crankshaft; weather-sealed high-tension outside magneto equipped with impulse coupling for quick starts in any weather, at any season; hone pistons; super-finished crankpins; extra-long connecting rods (2½ times the length of the crank throw); pump lubrication with individual oil stream to each rod; fuel pump as standard equipment; built-in flyball governor; oil bath air cleaner, and ¾-in. standard float feed carburetor.

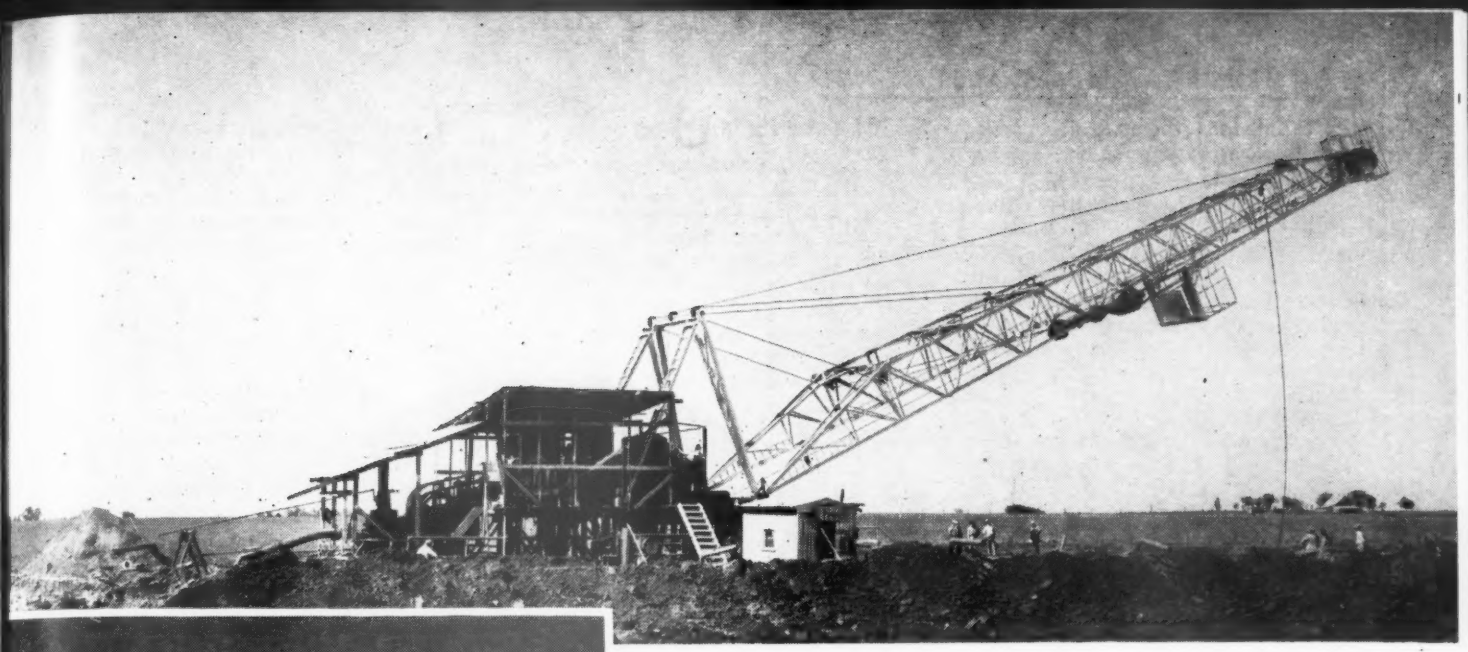
The Model TE, operating at 1600 to 2600 rpm, carries ratings of from 8.3 hp to 11.2 hp. The Model TF, at the same speeds, turns up from 9.9 to 13.3 hp. Standard engine weighs 220 lb. Also available as housed power unit, weighing 255 lb.

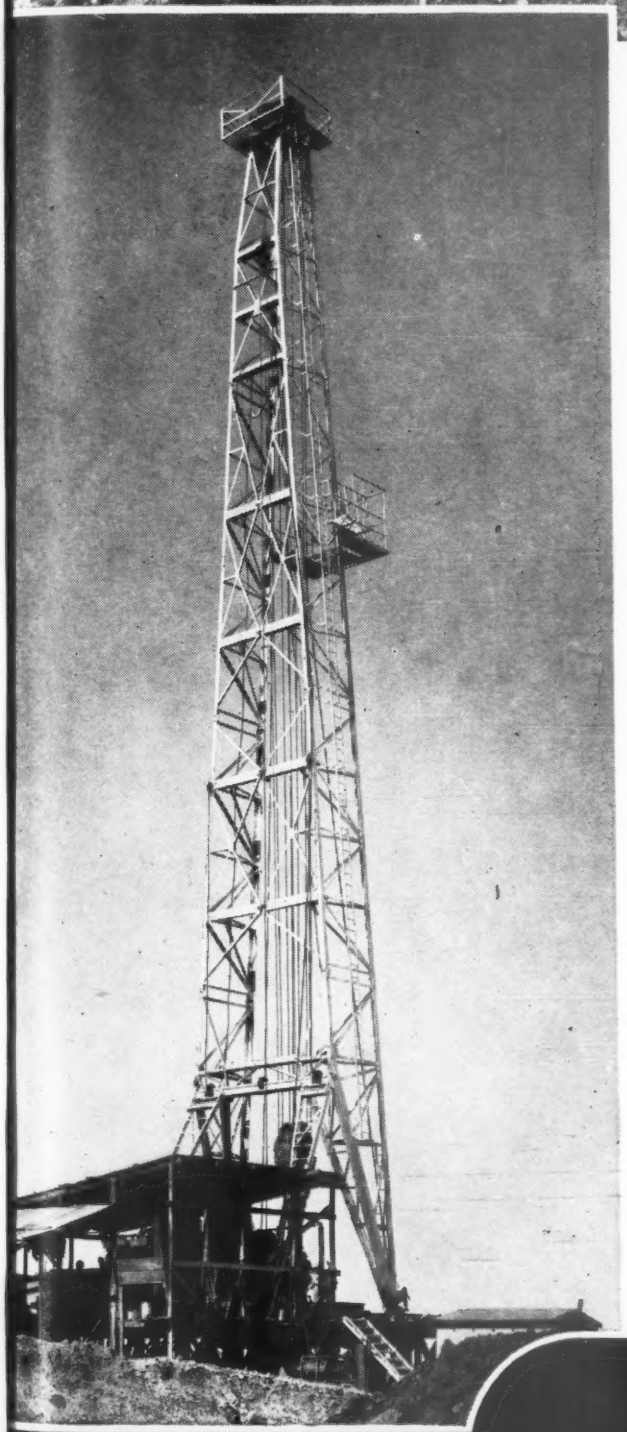
These engines can be supplied with electric starter and generator, clutch take-off assembly, and clutch reduction assembly.

They regularly operate on gasoline but can also burn other fuels.

The new two-cylinder engines fill the gap which has existed in the past between the single-cylinder line (2 to 9 hp) and the V-type 4-cylinder line (up to 30 hp).

Wisconsin Motor Corporation is the manufacturer.





Moore 129′ 136′

Portable Masts

These new, larger and more rugged Cantilever portable drilling masts retain all the well known features of easy transportation — fast erection — and ample working space which characterize Moore Masts.

Capacity of the 129′ Mast is 563,000 lbs., of the 136′ Mast is 830,000 lbs. Both rack pipe in trebles, accommodate the largest draw-works, powers and block equipment.

Any Lee C. Moore office will furnish complete specifications.

(8) Flexible welder

The advantages of the "Unionmelt" welding process (submerged melt welding) can now be made easily available anywhere in the shop, on any work that can be suitably positioned. This is accomplished with the new "Unionmelt" flexible welder, recently demonstrated publicly at the National Metals Exposition in Chicago by The Linde Air Prod-

ucts Company, unit of Union Carbide and Carbon Corporation.

The machine is particularly useful for making welds that are inaccessible for fully automatic welding, making short welds where it is not worthwhile to mechanize the operation, building up deposits of almost any size or shape, and depositing metal to repair weld or casting defects. The "Unionmelt" automatic flexible welder can be used as a primary welding tool in a small welding shop or as a supplementary tool for fully mechanized installations.

The special feature of this machine is that the welding nozzle, at the end of a 20-ft long flexible hose, when held in the operator's hands, can be moved from one weld to another without stopping to set up track, carriage, or other guiding equipment. The welding nozzle is easy to handle and guide along the seam or over the area to be built up.

(9) Saftyweld coupling

The Saftyweld Coupling is a device for safe, quick joint welding of pipe lines. It is used for section replacements, whether for the repair of an operating line, or a relocation of it. It accomplishes speed and thus saving of time and money because the operating line can be shut down, the coupling installed, pressurized, and clamped, and the line put back into operation immediately thereafter, before any welding is done, according to the manufacturer, Clark Goodman Supply Company. It accomplishes safety, because: (1) It eliminates use of hazardous mud, asphalt, rubber, vapor, or other packing; (2) welding can be done while the line is in operation, which according to standard safety codes is the safest condition for such welding, or (3) welding can be postponed for several weeks if necessary until dangerous leakages and fumes in the vicinity have been completely dissipated.

(10) Tube ice machine

In order to reduce the cost and eliminate the limitations of producing crushed ice, a new method of producing hard clear ice at once in small pieces of almost any desired size has been developed in the form of a tube ice machine.

The machine is of the vertical shell and tube type, designed similar to the well-known vertical tubular open-ended condenser. Such a vessel is supported over an inclined chute, consisting partly of solid and partly of screen metal.

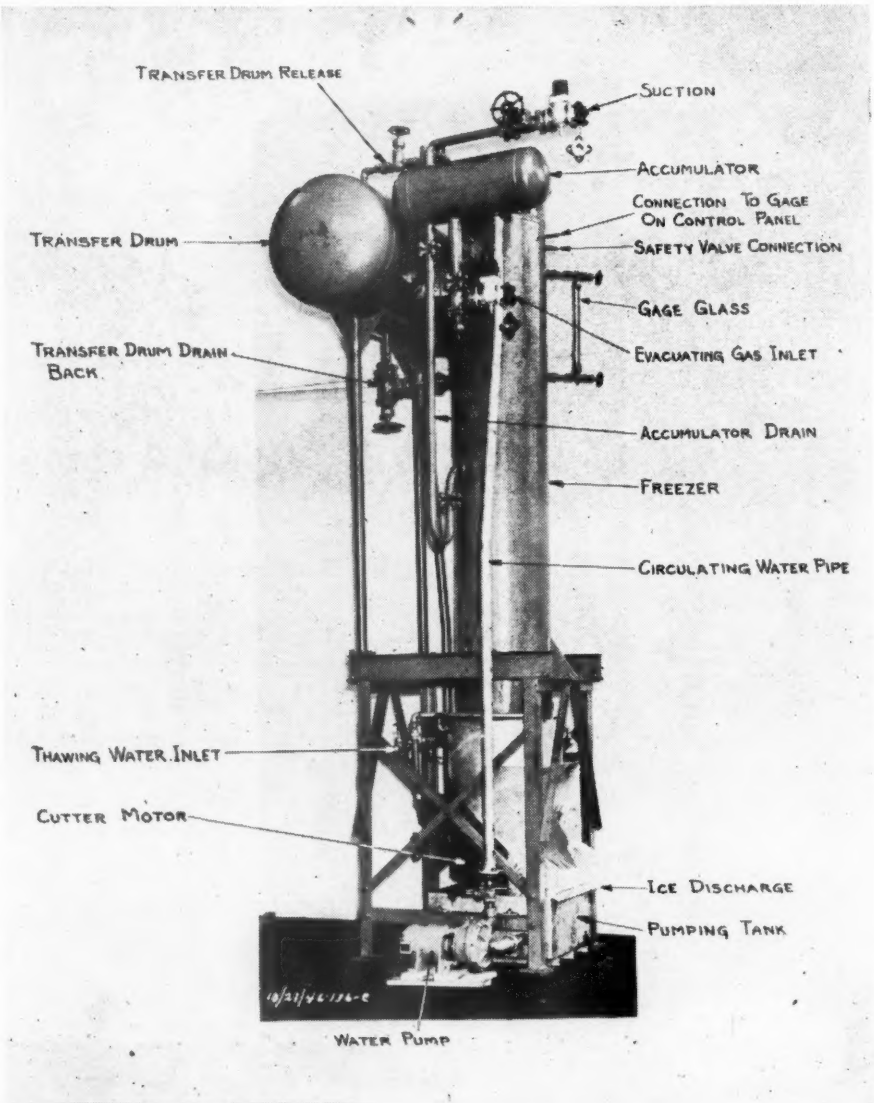
Below the chute is a water tank from which the water to be frozen is withdrawn by a pump and delivered to the top of the vessel where it is distributed evenly to the tubes. Each tube is provided with a metal distributor, which causes the water to be projected against the inner surface of the tube. This circulation of the water provides the agitation and washing action required to produce clear ice, as the water is continuously circulated during the freezing cycle.

Beneath the lower tube head a shear plate is attached to the tube plate by a ring, thus forming a closed chamber comprising an auxiliary thawing chamber through which a very small quantity of warm water is discharged at the desired moment to thaw the bottom end of the tubes. The shear plate relieves the tube head of any shock due to the cutting operation; the cutter lies just beneath the shear plate and is revolved by a small motor.

The vessel itself is filled with the refrigerant (usually ammonia) to the required height, determined by a float-controlled liquid feed valve situated at the proper level. Near the top of the vessel is a horizontal transfer drum into which the refrigerant from the freezer is periodically discharged and from which it is expelled and returned to the freezer.

The timing mechanism consists of a primary and secondary timer. The primary timer, which controls the freezing period, is a Telechron motor-driven device with a large scale and indicator by means of which the freezing period may be adjusted to provide any desired thickness of ice by rotating a very small knurled knob. The secondary timer mechanism consists of several cams of plastic material mounted on a horizontal shaft driven by a very small motor.

The equipment is manufactured by the Henry Vogt Company.



*Triple Duty.....

with a HAPPY PUMPER

Dependable, economical power when and where you want it — that's the prime requirement of any pumping equipment. Most every pumping Mid Continent Area field is dotted with Happy Pumpers — evidence of satisfactory performance.

*Here's a HAPPY PUMPER doing Triple Duty. A jerker pump—rear, and a second well—front, are hooked onto the bell crank. This hook-up pumps two oil wells and the pipeline jerker pump.

Happy Coolers
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Happy Pumping Units
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(11) Dead line anchor

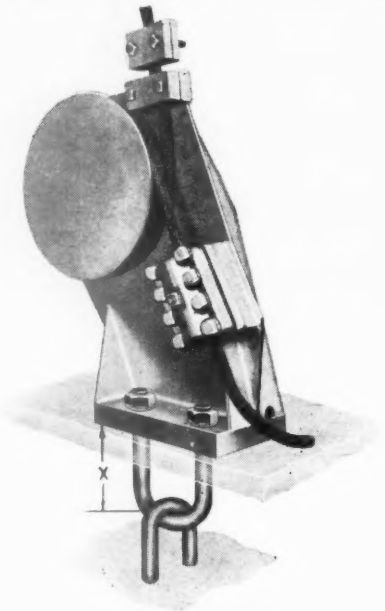
Two models of drum type dead line anchors have been placed in production by International Derrick and Equipment Company. One model is available for attachment to the corner column of the substructure and the other for anchoring to the derrick corner pier. Both models are similar in construction and operation. They are welded from steel plates, which holds weight to a minimum and insures ample strength at all stress points.

The drum type dead line anchor provides a safe and practicable method of securing the dead end of the drilling line, according to the manufacturer. No cable clips are used and no sharp bends are allowed that would have a tendency to damage the line, it is stated.

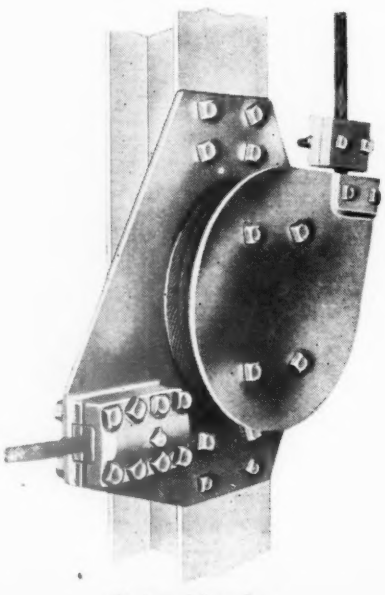
To anchor the dead line, three turns are taken around the large drum before the line passes through the bronze-lined form-fitting clamp. The drum functions much the same as a cathead. There is very little tension in the line at the clamp because of the snubbing action of the three wraps around the drum, and therefore there is little likelihood of the clamp damaging the line.

A slack clamp is placed on the working side of the line, which prevents uncoiling of the line on the drum when slack is thrown into the dead line.

By removing the slack clamp and loosening the bronze-lined clamp, a new section of line may be pulled from the storage spool through the blocks without removing the line from the drum.



Floor model anchor.

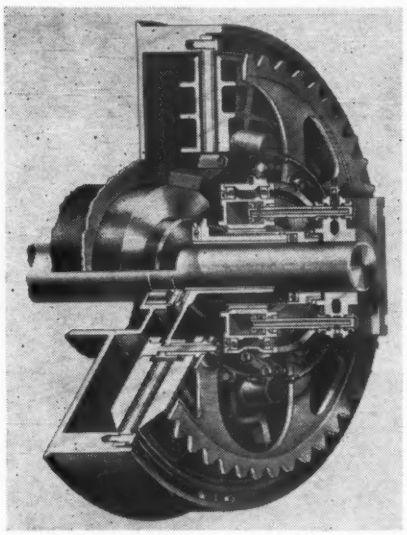


Post model anchor.

(12) Air clutch

"Franksair," the name for the full air clutch recently announced by Franks Manufacturing Corporation, affords smooth, efficient operation and is designed to give "finger tip" control, according to the manufacturer.

"Over-center" engagement or disengagement, lighter weight, and more drum capacity in less space, elimination of mechanical linkage, rotating air seals, drilled shafts, less heat as the air actuating mechanism is some distance from



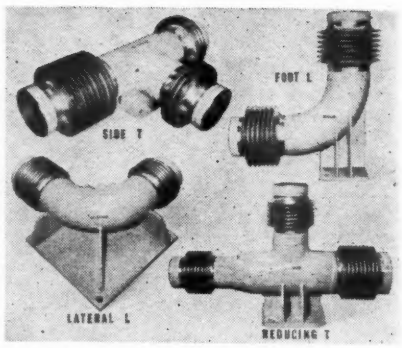
the area of clutch engagement, and single point hydraulically equalized adjustment are other features claimed.

The Franksair clutch-actuator positively engages or disengages by air pressure a final-friction drive winch clutch on a cylinder and piston incorporated into the clutch assembly.

It is a movable annular cylinder on a fixed shaft that operates as a piston and valve arrangement actuated by air pressure introduced in either "in" or "out" chambers and engaging or disengaging the Franks double faced center friction ring clutch.

(13) Expansion fittings

The addition of a new line of anchor base expansion joint pipe fittings to its six standard series of packless expansion joints is announced by MagniLastic, a division of Cook Electric Company. Four typical units are illustrated: A side "T", foot "L", lateral "L", and reducing "T", all of stainless steel. Note in the side "T" how number of bellows flanges may be varied to accommodate unequal expansion in each leg. Each of



these particular fitttings stem from the standard MagniLastic 400-lb series and is constructed for steam lines.

Complete expansion fittings solve many piping layout problems of limited space and multi-expansions. Pipes need only to be led to the fitting point and joined to proper unit, which is complete with anchoring base.

This new line will supplement regular MagniLastic expansion joints, which are made for a full range of pressures from 30 in. of vacuum to 1000 psi in pipe sizes from ½ in. to 72 in. Greater pressures and larger pipe sizes can be handled on special order.

(14) Well sounder

Sonolog is an instrument for the acoustic determination of the fluid level in the annular space between the casing and the tubing of an oil well. A small pressure-tight chamber attached to a casing outlet at the surface of the ground contains a microphone and a mechanism for firing a blank cartridge. The sound of the explosion travels down the annulus between the tubing and the casing; the sound is partially reflected at all obstructions such as tubing collars, tubing catcher, etc., and is finally reflected almost totally at the top of the column of oil, which usually extends some distance above the pump. The sound of the initial explosion, and also all reflected pulses, are transformed into an electric current by the microphone within the chamber attached to the wellhead. This current is amplified and recorded on a moving strip of paper by means of two pen-and-ink recording galvanometers operating simultaneously. The reflection from the top of the fluid appears on the record as a large disturbance superimposed on a succession of small kicks that result from the weak reflections at the tubing collars. Thus the top of the fluid is located with reference to the natural scale of tubing collars. The interpretation of the record requires only the counting of the number of tubing joints exposed above the fluid. A knowledge of sound velocity is not required.

The employment of two simultaneous recording channels, which are adjusted permanently for best response to different events, makes it possible to dispense with critical adjustments, and therefore enables semi-skilled personnel to obtain satisfactory results.

Keystone Development Corporation is the manufacturer.

men who know the ropes

take Tiger Brand every time!

● And, it's easy to see why . . . because U·S·S American TIGER BRAND Rotary Lines possess not just one or two, but *all* of the qualities needed to insure smooth performance, low-cost maintenance and long service life! Made to close tolerances and unvarying quality standards from the finest high tensile strength steel wire, TIGER BRAND combines strength, toughness, and flexibility to your greatest advantage. You can't buy better wire rope at any price! Immediate delivery of all sizes in either Excellay Preformed or non-preformed construction. See your supplier today. *Don't get caught with your lines down!*

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COLUMBIA STEEL COMPANY
San Francisco
United States Steel Export Company, New York
UNITED STATES STEEL

THE BIG DEMAND IS FOR TIGER BRAND

trade literature

PUBLICATIONS LISTED ARE SENT FREE UPON REQUEST

(15) Kobe free type pumping

Kobe free type pumping now makes the bottom hole pump, in any depth well, quickly available at the surface by the turning on and off of a wellhead valve. Pump pulling is eliminated, and with it the need for expensive servicing equipment, according to the manufacturer, Kobe, Inc.

Changing pumps is a one-man operation. In a 5000-ft well the bottom hole pump can be retrieved and a new pump run in within two hours. During only 30 min of that time it is necessary for the pumper to be present. A booklet "Free Type Pumping" is available.

(16) GM oil field engines

Detroit Diesel Engine Division of General Motors Corporation has issued a new bulletin that gives the latest specifications and technical data on all its oil field engines.

(17) New Merla catalog

Merla Tool Corporation has issued a new catalog revised as of January 1, 1948. Among the products described and illustrated are the Type "W" surface controlled intermitting valve, automatic differential flow valves, Type "AP" surface controller, packers, Merla-Parks pressure regulator, "Type 300" back-pressure regulator, chemical lubricator, orifice well tester, standing valve, hanger nipples, and filter drip.

(18) Ideco Hy-Lift rams

Since the introduction of the Rambler Rig, Ideco engineers have conducted a search for additional means of increasing its speed, efficiency, and mobility. The latest improvement consists of four hydraulically operated Hy-Lift Rams capable of lifting the entire unit nine feet in a single stroke. Special "A" frames are placed in position under the rig and held rigidly into position with turnbuckle braces. The entire unit is lowered in place on this substructure, the Hy-Lift Rams are retracted, the rotary substructure is positioned, the mast is raised, and the Rambler Rig is ready for action. Whether it is a drilling job with blowout preventers, or a production job with a high christmas tree, no time is wasted in rigging-up a Rambler Rig when it is equipped with Hy-Lift Rams, according to the manufacturer, International Derrick and Equipment Company. When operations do not require a high-level rig, the rams may be detached or shorter intermediate-lift rams provided.

(19) Manganese bronze chain bulletin

A new 4-page bulletin containing information on the use and construction of manganese bronze pintle and detachable chain is being offered by Valley Foundry and Machine Works, Inc., Fresno, California. All types of Valley manganese bronze chain are described and illustrated in detail with drawings, photographs, specifications, and price lists of standard makes and special pintle and detachable chains.

(20) Intex and Univalves

A new Edward catalog section describing forged steel chrome-molybdenum Intex and Univalves has been issued by Edward Valves, Inc. Univalves are welded bonnet integral seat valves for service at 1500 and 2500 psi at 1000 F. Intex valves are bolted bonnet integral seat valves rated at 1500 psi, 1000 F.

The bulletin gives details of construction, dimensional and design data, material specifications, and other data.

(21) Selecting steam trap

"Selecting the Right Type of Steam Trap" is the title of a 4-page, 2-color bulletin issued by Sarco Company, Inc. An illustrated chart permits the reader, at a glance, to select the right type of steam trap for his particular application. The special features, advantages, and recommendations are listed for each type of trap. Large, cross-sectional illustrations make it simple to follow the text.

(22) Cementing and production equipment

Publication and distribution of a new price book and general catalog is announced by Larkin Packer Company, Inc. The general catalog contains illustrations and descriptions of the entire line of Larkin cementing and production equipment.

(23) Self-cleaning air filter

A new 8-page booklet explaining the operation and application of the multi-duty self-cleaning air filter for engine and compressor service has been issued by American Air Filter Company, Inc. Installation photographs as well as detailed engineering data are included.

(24) BJ Hydroplex pump

Byron Jackson's new Bulletin No. 47-8020 describes the Hydroplex pump, a split case multi-stage centrifugal pump for low capacity and high pressure pumping.

The eight pages in two colors cover various views of the Hydroplex, including drawings, and installation photographs.

The Hydroplex pump is a smaller and more economical version of the BJ Hydropress, and presents various advantages over the complex displacement type pump such as uniform non-pulsating flow, variable capacities without bypass or speed change, no relief valves, vertical construction that requires only a simple foundation, and minimum floor space, according to the manufacturer.

The Hydroplex is equipped with a direct-connected electric motor. Head range is 450 to 1700 ft; operating speed 3550 rpm at 60 cycles and 2950 rpm at 50 cycles.

(25) Pipe line equipment

A new 4-page folder punched for loose leaf binding presents in easy reference form information and data on internal alignment clamps for pipe line welding (both hand operated and electric) expanders, and portable power units. All units are illustrated. M. J. Crose Manufacturing Company, Inc., produces the equipment.

(26) Stonhard resurfacer

Published by the Stonhard Company is a large colorful folder describing Stonhard Resurfacer, the heavy-duty material for repairs and overlays to concrete and wooden floors. Illustrations show several typical installations and demonstrate the versatility of this material in solving floor problems for a variety of industries. It is explained that costly chipping, necessary to anchor new concrete to old, and other expensive base preparations are eliminated in resurfacing or patching floors with Stonhard Resurfacer, as this material is applied at a thickness of ½ in. right over the old surface. The folder lists the characteristics of the material in an interesting safety-performance check list.

(27) Industrial wire cloth

The Newark Wire Cloth Company has released a new 4-page bulletin covering the company's complete line of woven wire cloth, metallic filter cloth, metallic bolting cloth, fabricated wire parts, ASTM testing sieves, and testing sieve shaker.

(28) Tweco electric welding equipment

A new 12-page Twecolog fully describes the complete line of Tweco welding electrode holders, ground clamps, cable connectors, machine terminals, cable splicers, lugs, and carbon holders. Quantity price and parts information is included. Bulletin shows new models.

(29) Franks oil field equipment

The Franks Manufacturing Corporation has announced its new catalog of oil field equipment. Containing field photographs of each Franks product, the catalog offers a complete presentation of the extensive line of Franks drilling rigs and servicing units.

The catalog presents the company's equipment in three sections: Well servicing units, drilling units, and miscellaneous products.

On any well... In any country... By any language

SHAFFER

is the only way to say complete pressure protection!

FROM ALL PARTS of the world operators bring their pressure control problems to Shaffer because Shaffer not only pioneered modern pressure control techniques, but has continually developed and made new advancements that make Shaffer equipment the safest, most convenient, most adaptable and dependable pressure control equipment available for today's drilling and production operations. Included in the complete Shaffer line are such universally accepted pressure control units as the following . . .

For unmatched pressure control while *Drilling!*

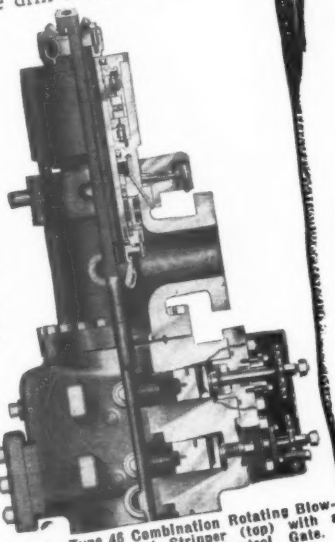
The Shaffer Type 46 Combination Rotating Blow-Out Preventer and Stripper combines in *one* unit every necessary feature for complete and foolproof pressure control while drilling under pressure. Maintains continuous leakproof seal around all elements in the drill string whether square, hexagonal, octagonal or round . . . and (except for such abnormally large tools as reamers and bits) the seal expands and contracts *automatically* to fit varying diameters in the string.

The unit not only maintains its seal while the drill string is rotating, but also while pipe is being stripped in or out of the well. There is nothing as complete, as advanced, as simple as this Shaffer unit!

The Shaffer Double Cellar Control Gate contains *two* complete ram compartments unitized into *one* body. The ram assembly in the upper compartment closes around the drill string when pipe is in the well, the ram assembly in the lower compartment closes off open hole when pipe is out of the well. Even in largest sizes (for 13⅜" casing) overall height of the Double Gate is *less than 29"*—smaller sizes even more compact.

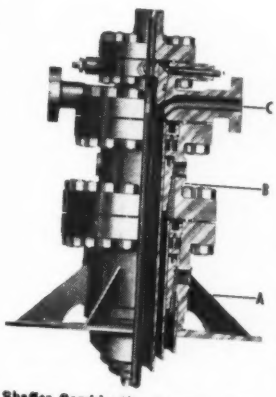
For applications where maximum conservation of vertical space is not essential, Shaffer also features a complete line of single Cellar Control Gates.

All Shaffer Cellar Control Gates are not only unusually compact, but are simple to install . . . are readily adaptable to any type of power drive—air, hydraulic, electric or steam, as well as manual. They have rams that are easy and quick to change . . . are operated by dependable foolproof *mechanical* drive . . . and incorporate many other vital advantages.



Shaffer Type 46 Combination Rotating Blow-Out Preventer and Stripper (top) with a Shaffer Double Cellar Control Gate.

For maximum pressure control while *Producing!*



Shaffer Combination Landing Base Head, with Spool Type Landing Head and Shaffer Type 46 Tubing Head

Operators throughout the world depend on Shaffer for efficient, compact and completely modern casing suspensions and pack-offs.

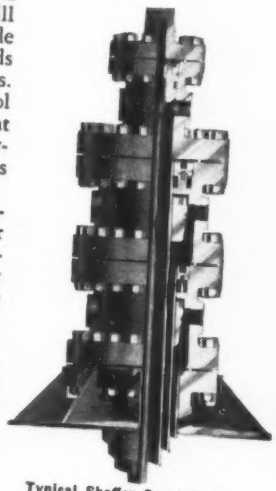
Shaffer Spool Type Landing Heads, the *pioneer* of this type of equipment, offer many unique advantages in simplicity of installation and maintenance. The Full-Opening design permits complete interchangeability of packing units to allow for change in casing sizes.

Where modern completion methods call for maximum installation compactness, the Shaffer Combination Landing Base Head (a) illustrated above is ideal. Although shown here with a Shaffer Spool Type Landing Head (b) and Shaffer Type 46 Tubing Head (c), where casing programs permit, the Spool Type Landing Head may be eliminated to provide still greater compactness. Also a wide selection of other Tubing Heads is available to meet varying needs.

The standard Shaffer Spool Type Landing Head arrangement shown below is another widely-used Shaffer design that offers many important advantages.

Five different types of packing units are available for Shaffer Heads to meet any completion requirement. In addition to regular types of packing assemblies, the Shaffer line also includes a recently-developed snap-ring type in which no threads are used in the internal bore of the Landing Head for holding the packing unit in place . . . and an all-metal packing unit for well conditions where this type of seal is desired.

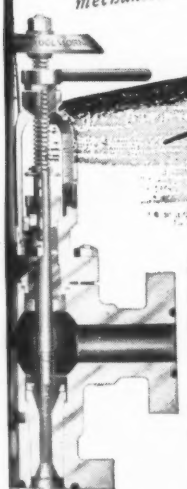
The complete line of Shaffer Heads also includes special-purpose Casing Heads, a full line of Tubing Heads, Multiple Zone Hook-Ups, Bases and other similar equipment!



Typical Shaffer Spool Type Landing Head with regular type Landing Base and Shaffer Type 35 Tubing Head

Refer to pages 3454 to 3506 of your 1947 Composite Catalog for helpful information on the complete Shaffer line of pressure control equipment, fishing tools and other advanced oil tool products.

Write for the complete new Shaffer Catalog!



For Controlling Fluid Flow:

SHAFFER ADJUSTABLE FLOW BEANS

Still another important line of Shaffer pressure control equipment is Shaffer Adjustable Flow Beans—the ideal unit for regulating fluid flow on drilling wells, on production hook-ups, in refineries and wherever accurate control is desired.

Shaffer pioneered this type of equipment also, and offers the most complete line for every need—Conical Tips, Micro Tips, and electrically-heated Thermo Tips . . . regular and hard metal types . . . and in a full range of sizes from 1" through 4".

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

SHAFFER TOOL WORKS, Brea, California • California Service Shops: Santa Fe Springs and Taft
HOUSTON, TEXAS, 6006 Navigation Blvd. • ODESSA, TEXAS, 1925 West Second Street
OKLAHOMA CITY, OKLAHOMA, Acme Oil Tool Company, 1001 S. E. 29th Street
EXPORT SALES OFFICE: Shaffer Tool Works, 30 Rockefeller Plaza, New York, N. Y., U. S. A.

No matter what your pressure control problem, bring it to Shaffer. Facilities to serve you throughout the world!

(30) Packaged A-C generators

Read "How to apply 'Packaged' A-C Generators" with seven handy tables for generator and wire selection, in the 16-page *Synchronizer*, Vol. 8, No. 3a, published by Electric Machinery Manufacturing Company.

(31) Safety and relief valves

A new 6-page illustrated Condensed Specifications Bulletin (No. 50), has been announced by Farris Engineering Corporation. This new bulletin facilitates the prompt selection of relief or safety valves by means of a carefully laid out detail index that comprises two full pages. This listing gives all type numbers and other pertinent data, together with comparison numbers of other commonly used valves. Sizes, pressures, and materials are all clearly indicated to assist the user in a ready choice of the proper equipment.

Another two pages are devoted to a display of 31 separate valve sectional line illustrations, which give the user a clear picture of the various types of valves indicated in the index.

A separate page is devoted to the story of nozzle valve features, which are an integral part of Farris valve design.

(32) Industrial protective clothing

A 12-page catalog section on industrial protective clothing has been published by The B. F. Goodrich Company. The publication pictures and describes both the rubber and the Koroseal (synthetic flexible material) garments it handles. Included are the Koroseal industrial rain coat, acid proof apron, sleeve protectors, work suit, film industrial apron, and heavy duty industrial apron.

Rubberized products pictured and described include the economy work coat, general purpose work coat, double back industrial coat, universal work suit, Ameripol storm suit, dress raincoat, junior police coat, Ameripol fishing smock, workers' leggings, work-n-weather hat, cyclone hat, police and fire coats, Ameripol shop apron, laboratory apron, heavy duty industrial apron and dairy and canners' apron, as well as rubber-canvas work gloves.

(33) Plastic coating for belting

A new plastic coating has been developed and tested by the Amercoat Division of the American Pipe and Construction Company, for use on rubber, rubber belting, and cotton belting. This coating, called Amercoat No. 40, combines the properties of synthetic rubber with the chemical resistance of Vinyl resins to produce a film of unusual toughness and flexibility with excellent water resistance. Amercoat No. 40 will stand continuous flexing and has excellent adhesion to rubber, canvas, metal, concrete, and wood after the surface has been properly prepared. This coating is recommended for conveyors and other belting subject to abrasion, spillage of water, grease, oil, and other chemical solutions and cleaning agents.

(34) Two welding bulletins available

Two bulletins issued recently by Eutectic Welding Alloys Corporation are now announced as special reprints to meet demands for them as reference sources by those interested in production and maintenance welding at low base metal heat.

Entitled, "Arc Welding Problems Successfully Solved" one bulletin covers welding cast-iron, low and high alloy steels, stainless steel and tool steels to high carbon steels; welding special manganese parts, elimination of undesirable characteristics, and other problems occurring in everyday welding.

The other bulletin, "Another Major Advance in Gas Welding," describes the use and applications of various new developments in the field of special flux-coated alloys known as Eutec-Rods, for steel, cast-iron, brass, and aluminum. Correct welding procedures, together with physical properties, charts, and valuable technical data are well outlined and illustrated. Applications discussed include steel, cast iron malleable, bronze, brass, and copper.

(35) Air cylinder catalog

Miller Motor Company has issued a new bulletin that will save engineers time and trouble by supplying complete information on air cylinders from 1½ to 14-in. bores. Single and double rod end non-rotating cylinders are shown with or without cushions, and with a choice of standard and many oversize piston rod diameters .Full mounting dimensions and installation drawings are presented on 16 models of double acting and single acting cylinders with and without spring return so that the design engineer has all information he requires in laying out his machine.

(36) Solid rotor steam turbine

A fully illustrated, 8-page booklet on the solid rotor type steam turbine has been released by The Whiton Machine Company. The booklet shows in detail the many engineering features of the company's product. In addition there are engineering drawings and dimensional data that should be useful in selecting turbines needed for specific applications.

(37) Multiple arm relays

A new line of sensitive multiple arm relays has been announced by Signal Engineering and Manufacturing Company. The line comprises a new series of small, rugged, general purpose multiple arm relays adaptable to a wide variety of circuit arrangements. Features include: Mounting area minimized; vertical, balanced armature; interchangeable unit contact pile-ups; unusually high contact pressures; shock and vibration resistant. Three styles of assemblies: 1. Octal socket and removable dust cover. 2. Octal socket and hermetically sealed cover. 3. Header type container, hermetically sealed. Bulletin No. 50-47 is available.

(38) Steam jet ejectors

A new catalog No. 1462, entitled "Steam Jet Ejectors," has been issued by the C. H. Wheeler Manufacturing Company. This catalog contains 36 pages and includes 30 sectional drawings, also flow diagrams, engineering data, installation guide, formulae, curves, and tables. It covers the theory and operating characteristics of steam jet ejectors for all classes of vacuum service, including single, two, three, four, and five stage types. Non-condensing and condensing types, with barometric inter- and-after-condensers for vacuum requirements in chemical plants, food plants, sugar refineries, oil refineries, power plants, etc., are fully covered.

(39) Metal protection

How to secure "Lasting Protection for Metal Surfaces" is the theme of a 12-page, illustrated booklet just released by The Arco Company.

It presents comprehensive data on Dum Dum for Metal, the new tough but pliable and elastic water-repellant coating developed by Arco to protect metal structures against deterioration due to outdoor exposure.

Properties, advantages, typical uses and application directions are included.

(40) Heliweld descriptive folder

The Air Reduction Sales Company has published two-color profusely illustrated 8-page folder describing its three new types of Heliweld equipment. These are the manual holder, the machine holder, and the electronically controlled automatic head. The new folder offers photographic illustrations of Airco's three new types of Heliweld equipment. It lists advantages and uses of the process, construction details of the equipment, and a page devoted to supplementary equipment and supplies.

(41) Putting refining unit on stream

Utilizing the novel pattern of the personal diary in a day-by-day, almost hour-by-hour record of events, the story of the critical period of putting a new oil refining unit on-stream is dramatically described in the latest issue of the *Kelloggram* published by The M. W. Kellogg Company, engineers, of New York.

Entitled "Report from Casper," the diary depicts, in the crisp sentences of the engineer's report, the problems that were faced and solved by the technical staff during the vital 3-day period of starting up a fluid catalytic cracking unit for The Texas Company at Casper, Wyoming.

From the moment of starting up the fractionator, through heating, catalyst loading, charging oil to the reactor, which marked the official starting-point, and finally to the operation of gas recovery section, the story moves forward swiftly in pictures and text. The vessels and equipment that make up the unit are very fully described through photographs and captions positioned in the article where the item is treated in the text.

TWIN DISC

Parts readily available

Replacements easy, simple and quick

At some point in its service-life, every machine or accessory which is steadily employed requires a new part. Whether this be due to accident, abuse or ordinary wear, the important point is to be able to get the part in the shortest time and install it with the least possible delay, to minimize the cost of "down-time."

Recognizing the manufacturer's responsibility, the Twin Disc Clutch Company did two things:

First, Twin Disc engineers designed the diversified line of standard Twin Disc Clutches and Hydraulic Drives to make parts replacement simple, easy, quick.

Second, the Twin Disc Clutch Company has made replacement parts for its units *quickly available* either through those manufacturers who furnish Twin Disc products as original equipment or through the Twin Disc Clutch Company's 6 factory branches and 31 parts stations, near all important industrial centers.

That's one reason why builders of all types of oil field machinery say: "Let's standardize on Twin Disc Friction Clutches or Twin Disc Hydraulic Drives." TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).

Illustrated:
Top—Model E Clutch. Center—Model P Air-Actuated Clutch. Below—Power Take-off.

SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

Intermediate alloy steels at elevated temperatures

By R. F. MILLER, Research and Technology Division
Carnegie-Illinois Steel Corporation
United States Steel Corporation Subsidiary

EXCLUSIVE

THE development of the petroleum, chemical, and power industries to a greater efficiency and economy depends to a considerable extent upon the use of higher and higher operating pressures and temperatures; higher stresses at higher temperature for the steel involved. Representative installations requiring steels for service at high temperatures and pressures include oil stills, cracking units, pumps, valves, pressure tanks, boilers, superheaters, and high pressure steam piping.

In view of the requirements and possible safety hazards involved in this type of service, the steels used should have the following qualities:

(a). Adequate strength at elevated temperatures.

(b). Resistance to oxidation and attack by the corroding media to which it may be exposed in service.

(c). Good ductility and toughness during its period of service.

(d). Weldability, if the application involves welding.

(e). Generally satisfactory fabrication characteristics, i.e., suitable for rolling, forging, or tube piercing.

The relative importance of these characteristics depends upon the application, but creep strength and corrosion resistance are of prime importance. It has been found that the determinations of tensile strength, yield strength, and elastic limit, when measured in a short time test at high temperature, are inadequate. When materials are maintained at high temperature even under a relatively low stress, a gradual yield or extension occurs. This gradual yield, because of its small magnitude, has been termed "creep" and is customarily expressed in terms of stress for a given rate of elongation. For example, the stress that causes elongation at a rate of 1 per cent per 100,000 hr, or of 1 per cent elongation per 10,000 hr, is termed the creep stress for the material at the particular temperature involved. For certain applications, such as steam turbines, total elongation rather than the rate is of greatest importance, for the operational tolerances are very small; furthermore materials under stress at high temperature do not necessarily elongate most rapidly during the early period of service. The stress for rupture in a certain time period is also used as a basis for design, particularly where the amount of deformation may be large enough to result in failure of the metal during its service life.

Factors influencing the creep and rupture characteristics are primarily the presence of effective alloys and the microstructure that has been induced by suitable heat treatment. Study of this problem has been extensive and, although it is believed that the alloying elements that have low diffusion rates and form carbides, such as molybdenum, chromium, tungsten, vanadium, and titanium, are most effective in producing a steel of high creep strength, other elements are frequently used either to assist in obtaining this quality or for oxidation and corrosion resistance. The classes of steels used may range from the austenitic high chromium-nickel stainless alloys to pearlitic steels of moderate alloy content or simple carbon steels, the selection of which must depend upon the conditions of service.

Tables 1 to 10 list the steels most commonly used in the petroleum refining industry, together with their properties at elevated temperatures. The ASME maximum allowable stress is taken from Table U-2 of the ASME Code for Unfired Pressure Vessels and represents a summary of the best available information, plus a factor of safety, based on service experience. A special ruling of the ASME Boiler Code Committee permits the increase of the maximum allowable working stresses by a factor of 1.25 under certain conditions.

Tensile, creep, and rupture properties listed in the tables and used in drawing the curves are based on tests carried out in the research laboratories of the United States Steel Corporation combined with the best available data from the literature (see bibliography). The spread in values is due primarily to three factors, namely:

1. *Heat treatment.* The strength of steels at elevated temperatures is profoundly affected by the heat treatment employed for the material. Carbon and molybdenum steels are used in the as-rolled, normalized, or annealed condition, while the air-hardening chromium-molybdenum steels are normalized and

TABLE 1. 0.5 per cent molybdenum steel—properties at elevated temperature*. Composition range covered by specifications (per cent).

C	Mn	Si	P	S	Mo
0.08/0.28	0.30/0.90	0.10/0.50	0.040 max	0.050 max	0.40/0.65

Property	Temperature, F							
	700	800	900	1000	1100	1200	1300	1400
ASME Maximum allowable stress† (1000 psi)	10.6-15.0	10.4-14.4	10.0-10.4	5.0				
Tensile strength (1000 psi)	*61.0-74.0* 68.0	*56.0-71.0* 63.5	*50.5-66.0* 57.0	*43.5-57.5* 48.0	*35.0-42.0* 37.5	*24.5-29.0* 26.5	*16.0-20.0* 18.0	*10.0-13.0* 11.5
Yield strength (1000 psi)	*20-28* 24	*20-28* 24	*20-28* 24	*20-27* 23	*16-24* 20	*13-18* 15	*9.5-13* 11	*5.5-6* 5.5
Elongation (per cent in 2 in.)	*30-38* 35	*28-36* 33	*25-35* 30	*29-40* 33	*32-48* 40	*38-60* 50	*50-80* 68	*77-94* 88
Reduction of area (per cent)	*60-80* 70	*62-82* 72	*64-84* 75	*67-86* 78	*70-88* 82	*72-90* 85	*80-95* 90	*85-100* 95
Creep strength 1 per cent in 10,000 hr (1000 psi)		*26-35.5* 30	*16-30* 20	*9-22* 12	*2-4* 3	*1-2* 1.5		
Creep strength 1 per cent in 100,000 hr (1000 psi)		*16-23.5* 18	*8-24* 12	*3-11* 5	*1-2* 1.5	*0.2-0.9* 0.4		
Rupture strength 1000 hr—(1000 psi)			*40-53* 44	*24-37.5* 28	*8-8.5* 8.2			
Rupture strength 10,000 hr—(1000 psi)			*32-52* 34	*12.5-22* 16	5			
Oxidation (weight loss in grams per sq in. after 168 hr in air at the indicated temperatures)	nil	nil	nil	0.03	0.06	0.35	0.71	1.49
Linear thermal expansion (inches per foot—from 70 F to the indicated temperatures)		0.067		0.089		0.111		

*Values in italics show spread of available data, and accompanying single values are a conservative average of the data. Single values, only, represent limited data.

†For this grade, the allowable stresses differ, depending on the particular specification being used.

B&W NICLOY TUBES give longer service in ALKALINE conditions... and LOW temperatures

WHEREVER tubing is needed that is highly resistant to severe alkaline corrosion or to low-temperature embrittlement, B&W Nicloy Seamless Tubes can be depended upon to provide the right answer. Because they have been developed expressly to combat those tube hazards, Nicloy Seamless Tubes give long, satisfactory service life, and at moderate cost. Nicloy Tubes are much more resistant to attack by alkaline media—and have higher impact values at sub-zero temperatures—than do any carbon steels and many of the usual alloy steels.

Nicloy Tubes are especially suited to such applications as: handling crude oils with substantial salt water and hydrogen sulphide content; handling liquefied gases or other low-temperature fluids in such processes as oil dewaxing; for caustic solution evaporation and alkaline-phenol solution work.

Three grades—with 3½, 5 and 9 percent nickel content respectively*—enable you to take advantage of Nicloy tubes in a wide variety of corrosive conditions. Nicloy tubes are easy to roll in, expand and flare; of uniformly high quality and made to close dimensional tolerances.

*Chemical Compositions

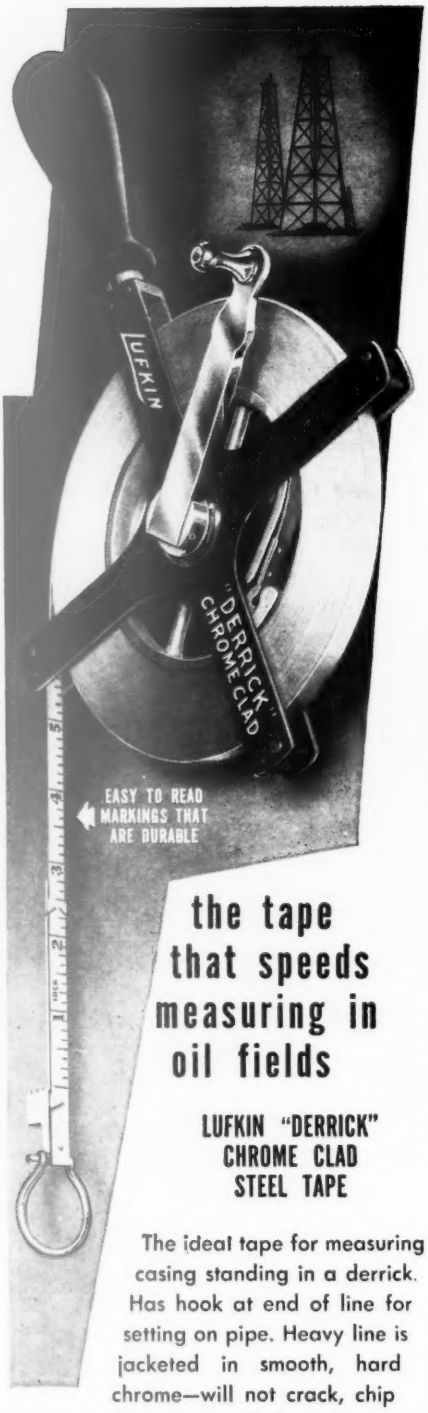
	Nicloy 3½	Nicloy 5	Nicloy 9
% Carbon	.20 Max.	.14 Max.	.12 Max.
% Manganese	.30 - .60	.30 - .60	.30 - .60
% Phosphorus	.040 Max.	.040 Max.	.030 Max.
% Sulphur	.040 Max.	.040 Max.	.030 Max.
% Silicon	.35 Max.	.35 Max.	.15 - .30
% Nickel	3.25-3.75	4.75 - 5.25	8.00 - 10.00

TA-14225

B&W

BABCOCK & WILCOX SEAMLESS & WELDED TUBES

THE BABCOCK & WILCOX TUBE COMPANY
GENERAL OFFICES: BEAVER FALLS, PA.
PLANTS: BEAVER FALLS, PA. AND ALLIANCE, OHIO.



the tape that speeds measuring in oil fields

LUFKIN "DERRICK" CHROME CLAD STEEL TAPE

The ideal tape for measuring casing standing in a derrick. Has hook at end of line for setting on pipe. Heavy line is jacketed in smooth, hard chrome—will not crack, chip or peel. Jet black markings are easy to read, recessed so they can't wear out. 4-arm frame with large winding handle. Get the best—order the Lufkin "Derrick" through your supply house. For free catalog write THE LUFKIN RULE CO., SAGINAW, MICH., New York City.

LUFKIN

FOR ACCURACY

tempered or annealed. The annealing practices employed vary, and include the sub-critical or stress-relief anneal (a high temperature tempering treatment), the mill or process anneal at temperatures within the critical range, and the full anneal from above the critical range.

The steels are purchased to specifications having room temperature mechanical strength and hardness requirements, and the steels are heat treated to produce these properties. As these properties may be produced by several of the above heat treatments, few, if any, of the various

TABLE 2. 1 per cent molybdenum steel—properties at elevated temperatures*. Composition range covered by specifications (per cent).

C	Mn	Si	P	S	Mo
0.10/0.20	0.30/0.60	0.10/0.20	0.040 max	0.045 max	0.90/1.10

Property	Temperature, F							
	700	800	900	1000	1100	1200	1300	1400
ASME Maximum allowable stress (1000 psi)								
Tensile strength (1000 psi)	67	66	64	58	52	39		
Yield strength (1000 psi)								
Elongation (per cent in 2 in.)								
Reduction of area (per cent)								
Creep strength 1 per cent in 10,000 hr (1000 psi)		*35*	*27-27.5* 27	*11.6-13.8* 13				
Creep strength 1 per cent in 100,000 hr (1000 psi)		*25*	11	5.5				
Rupture strength 1000 hr—(1000 psi)								
Rupture strength 10,000 hr—(1000 psi)								
Oxidation (weight loss in grams per sq in. after 168 hr in air at the indicated temperature)	nil	nil	nil	0.04	0.07	0.55	1.14	1.71
Linear thermal expansion (inches per foot—from 70 F to the indicated temperatures)		0.069		0.092		0.115		

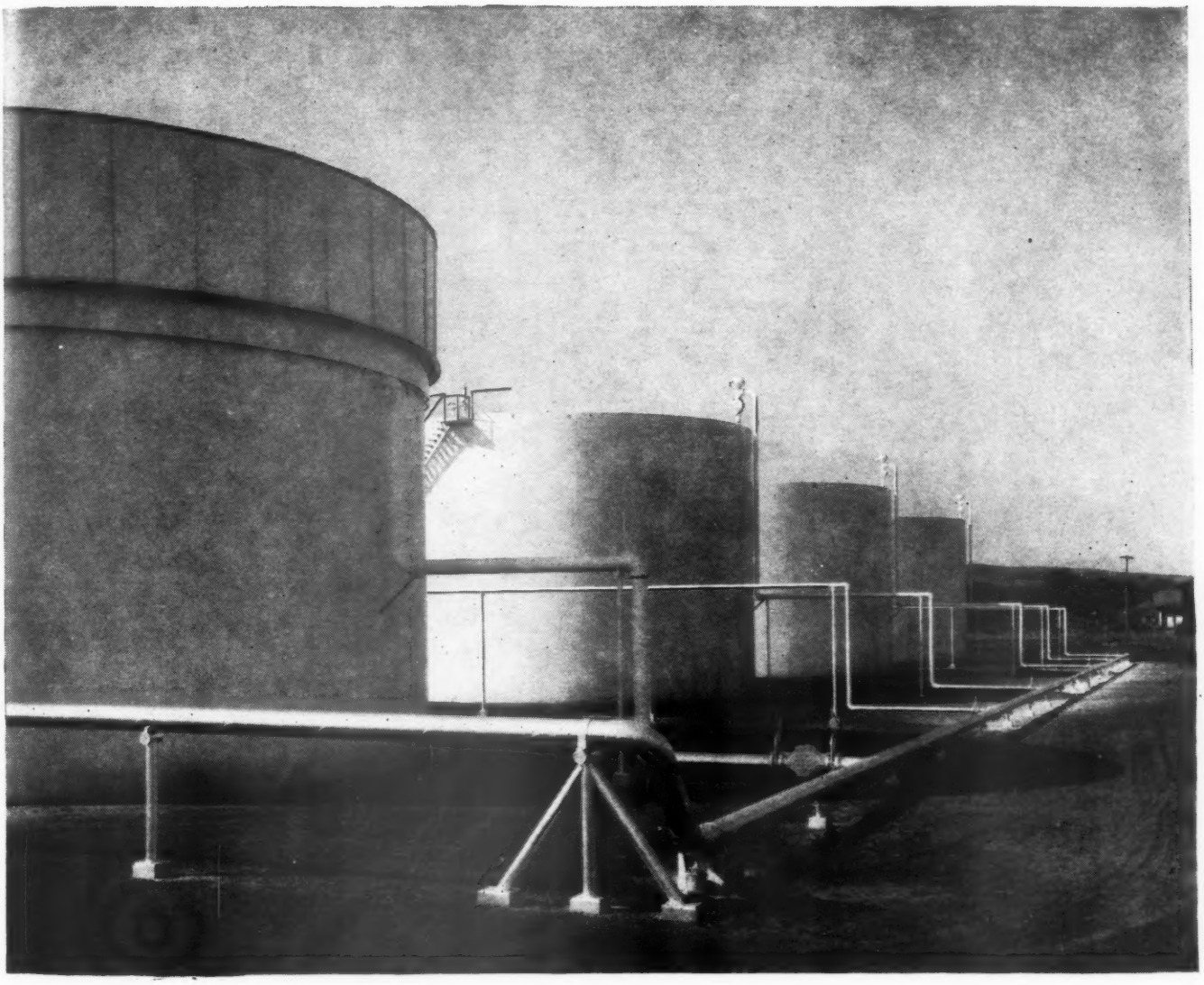
*Values in italics show spread of available data, and accompanying single values are a conservative average of th data. Single values, only, represent limited data.

TABLE 3. 1.25 per cent Cr, 0.75 per cent Si, 0.50 per cent Mo—properties at elevated temperatures*. Composition range covered by specifications (per cent).

C	Mn	Si	P	S	Cr	Mo
0.15 max	0.30/0.60	0.50/1.0	0.040 max	0.050 max	1.0/1.5	0.45/0.65

Property	Temperature, F							
	700	800	900	1000	1100	1200	1300	1400
ASME Maximum allowable stress (1000 psi)	12.0	11.8	10.0	5.85	2.2			
Tensile strength (1000 psi)	*72.5-74.5* 73	*69-72* 71	*64-67.5* 65	*54-57.5* 56	*40-47.5* 44	*27-33* 30	*17-22.5* 20	*11-13.5* 12
Yield strength (1000 psi)		*26-39.5* 32.5	*25.5-35* 31.5	*24.5-31.5* 27.5	*23-25.5* 24	*16-19* 17.5	11	7
Elongation (per cent in 2 in.)		*23-30* 25	*24-29* 26	*26-31* 29	*29-41* 34	*32-55* 45	61	72
Reduction of area (per cent)		66	68	74	82.5	89	94	98
Creep strength 1 per cent in 10,000 hr (1000 psi)		*27-29* 28	*17-25* 20.5	*8-22.5* 12	*3.5-7.5* 6	*1.5-3.8* 2.5		
Creep strength 1 per cent in 100,000 hr (1000 psi)		20.5	14.5	*8-13* 8.5	*2-4.5* 3	*0.5-2* 1.2		
Rupture strength 1000 hr—(1000 psi)						7	2.8	0.9
Rupture strength 10,000 hr—(1000 psi)					10.8	4	1.3	0.4
Oxidation (weight loss in grams per sq in. after 168 hr in air at the indicated temperatures)	nil	nil	nil	0.02	0.07	0.24	0.67	1.19
Linear thermal expansion (inches per foot—from 70 F to the indicated temperatures)		0.066		0.087		0.110		

*Values in italics show spread of available data, and accompanying single values are a conservative average of the data. Single values, only, represent limited data.



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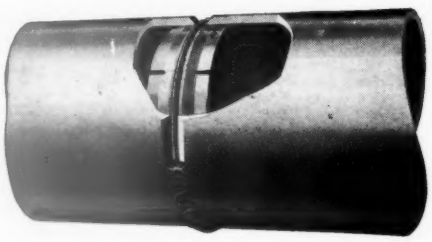

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TABLE 4. 1.75 per cent Cr, 0.75 per cent Si, 0.75 per cent Mo—properties at elevated temperatures*. Composition range covered by specifications (per cent).

C	Mn	Si	P	S	Cr	Mo
0.15/0.25	0.40/0.60	0.45/0.75	0.040 max	0.050 max	1.5/2.0	0.60/0.80

Property	Temperature, F							
	700	800	900	1000	1100	1200	1300	1400
ASME Maximum allowable stress (1000 psi)	12.0	11.8	10.0	5.85	2.2			
Tensile strength (1000 psi)	73	71.5	66.5	56	42	29	19	11
Yield strength (1000 psi)	47.5	46	43	40				
Elongation (per cent in 2 in.)	22	22.5	25	31				
Reduction of area (per cent)	68	69.5	74	80				
Creep strength 1 per cent in 10,000 hr (1000 psi)			29	11.2	6			
Creep strength 1 per cent in 100,000 hr (1000 psi)								
Rupture strength 1000 hr—(1000 psi)								
Rupture strength 10,000 hr—(1000 psi)								
Oxidation (weight loss in grams per sq in. after 168 hr in air at the indicated temperatures)	nil	nil	nil	0.04	0.06	0.35	0.91	1.53
Linear thermal expansion (inches per foot—from 70 F to the indicated temperatures)		0.066		0.087		0.110		

*Limited data available.

TABLE 5. 2 per cent Cr, 0.5 per cent Mo—properties at elevated temperatures*. Composition range covered by specifications (per cent).

C	Mn	Si	P	S	Cr	Mo
0.15 max	0.30/0.60	0.50 max	0.030 max	0.030 max	1.75/2.25	0.45/0.65

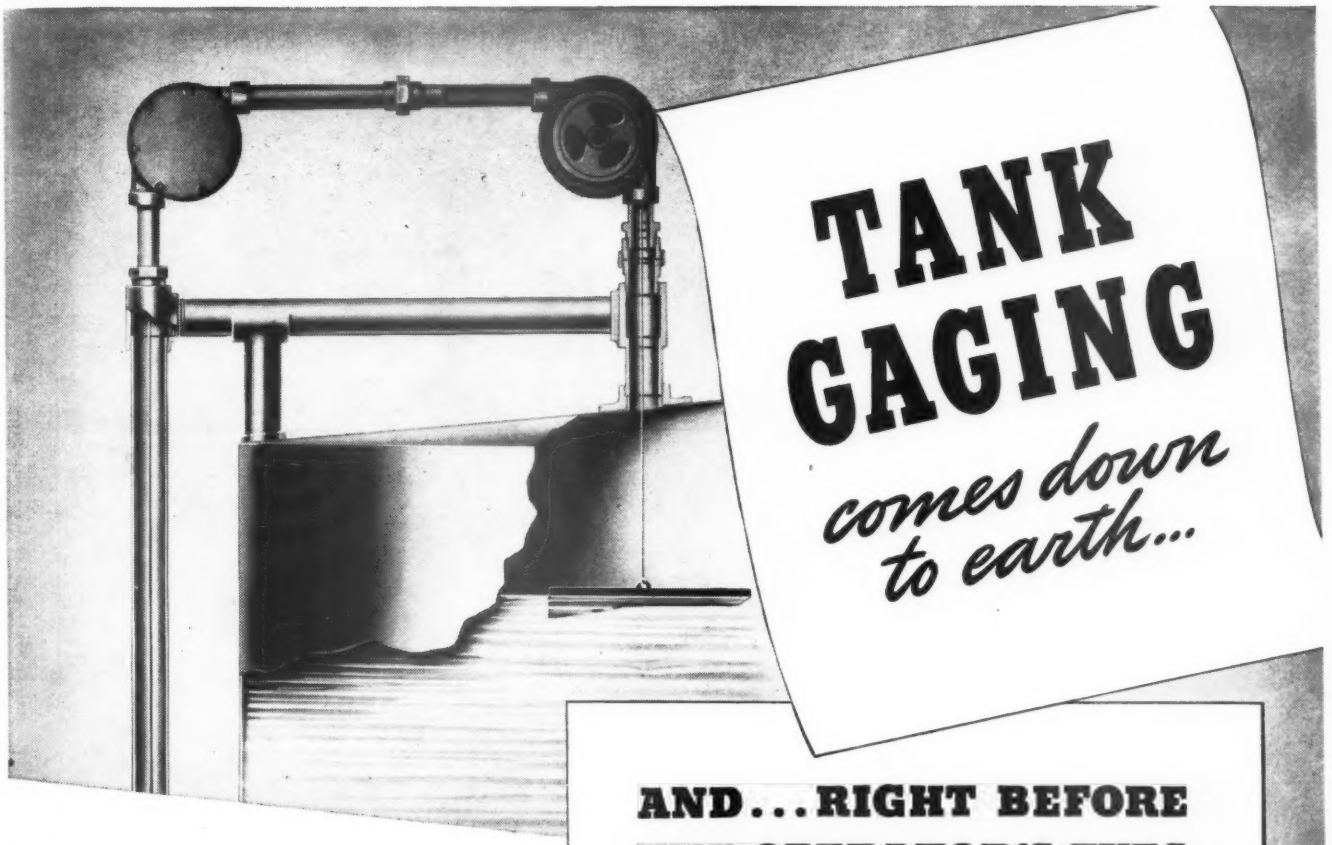
Property	Temperature, F							
	700	800	900	1000	1100	1200	1300	1400
ASME Maximum allowable stress (1000 psi)	12.0	11.8	10.0	5.85	2.2			
Tensile strength (1000 psi)	65	*58.5-64* 62	*53-61.5* 57	*46.5-53.5* 49	*38-44* 40	*25-30* 28.5	*16-20* 18.5	*10-11* 10.5
Yield strength (1000 psi)		25	22.5	20	18	15	11	7.5
Elongation (per cent in 2 in.)		28	32	36	43	59	71	84
Reduction of area (per cent)		65	71	77	84	88	92	96
Creep strength 1 per cent in 10,000 hr (1000 psi)			*18.8-20* 19.2	*9-12.8* 10.5	*5-6* 5.5	*3-3.5* 3.2		
Creep strength 1 per cent in 100,000 hr (1000 psi)			14.3	*5-6.2* 5.5	*3.2-4* 3.5	*0.8-1.5* 1.2		
Rupture strength 1000 hr—(1000 psi)								
Rupture strength 10,000 hr—(1000 psi)								
Oxidation (weight loss in grams per sq in. after 168 hr in air at the indicated temperatures)	nil	nil	nil	0.03	0.06	0.29	0.63	1.04
Linear thermal expansion (inches per foot—from 70 F to the indicated temperatures)		0.066		0.087		0.110		

*Values in italics show spread of available data, and accompanying single values are a conservative average of the data. Single values, only, represent limited data.

types of steel are used in only one condition of heat treatment, accounting for much of the spread in the data. It should be emphasized that the specifications do not contain requirements concerning the properties of the steels at elevated temperatures.

2. *Composition.* All specifications permit some latitude in composition, which is inevitably reflected in a range of mechanical properties, both at atmospheric and elevated temperature.

3. *Manufacturing practice.* In general, coarse grained silicon killed steels have higher creep and rupture strengths than the fine grained aluminum killed steels, although the coarse grained steels are more susceptible to strain aging and blue brittleness in the temperature range of 400-600 F.



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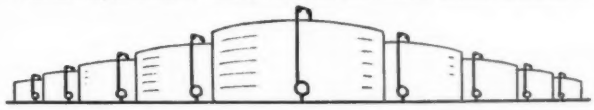

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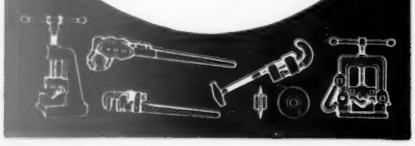


TABLE 6. 2 per cent Cr, 1.25 per cent Si, 0.5 per cent Mo steel—properties at elevated temperatures*. Composition range covered by specifications (per cent).

C	Mn	Si	P	S	Cr	Mo
0.15 max	0.50 max	1.0/1.4	.030 max	.030 max	1.75/2.25	0.45/0.65

Property	Temperature, F							
	700	800	900	1000	1100	1200	1300	1400
ASME Maximum allowable stress (1000 psi)								
Tensile strength (1000 psi)	67.5	62.5	56.0	48.0	37.0	27.0	18.0	11.0
Yield strength (1000 psi)		29	25.5	22.5	19.5	15	10.5	6
Elongation (per cent in 2 in.)		31.5	35	42	49	60	32	100
Reduction of area (per cent)		70	74	80	86	92	96	98
Creep strength 1 per cent in 10,000 hr (1000 psi)			13.6	7.5	4.5	3.5		
Creep strength 1 per cent in 100,000 hr (1000 psi)			10	5.6	2.4	1.4		
Rupture strength 1000 hr—(1000 psi)			33	20	11	6.4		
Rupture strength 10,000 hr—(1000 psi)			27	15	7	4.2		
Oxidation (weight loss in grams per sq in. after 168 hr in air at the indicated temperatures)	nil	nil	nil	0.01	0.02	0.03	0.04	0.09
Linear thermal expansion (inches per foot—from 70 F to the indicated temperatures)		0.006		0.087		0.110		

*Limited data available.

TABLE 7. 2.5 per cent Cr, 0.75 per cent Si, 0.5 per cent Mo—properties at elevated temperatures*. Composition range covered by specifications (per cent).

C	Mn	Si	P	S	Cr	Mo
0.15 max	0.50 max	0.50/1.0	0.030 max	0.030 max	2.25/2.75	0.45/0.65

Property	Temperature, F							
	700	800	900	1000	1100	1200	1300	1400
ASME Maximum allowable stress (1000 psi)								
Tensile strength (1000 psi)	65	60.5	55	47.5	38	29	19	12.5
Yield strength (1000 psi)		26	24.5	22.5	20	16	11.5	7.5
Elongation (per cent in 2 in.)		33	39	43	50	60	70	75
Reduction of area (per cent)		69.5	75	80	86	90	93	96
Creep strength 1 per cent in 10,000 hr (1000 psi)		26.5	15.0	9.0	5.0	2.1	1.5	
Creep strength 1 per cent in 100,000 hr		21.0	11	5.5	2.7	0.8		
Repture strength 1000 hr—(1000 psi)								
Rupture strength 10,000 hr—(1000 psi)								
Oxidation (weight loss in grams per sq in. after 168 hr in air at the indicated temperatures)	nil	nil	nil	0.03	0.05	0.20	0.46	0.90
Linear thermal expansion (inches per foot—from 70 F to the indicated temperatures)		0.066		0.087		0.110		

*Limited data available.

Furthermore, some of the steels are manufactured to several specifications as listed below. The individual compositions and room temperature properties are shown in these specifications. Maximum allowable working stress, corresponding to the composition in question, will be found in the ASME Table U-2 of the Code for Unfired Pressure Vessels.

ASTM specifications

0.5 Mo steel (Table 1)
- A204-46, Grades A, B, and C
- A234-44
- A182-46, Grade F1
- A161-46
- A209-46, Grades T1, T1A, T1B
- A206-46, Grade P1

1.0 Mo steel (Table 2)
- None

1.25 Cr-0.50 Mo steel (Table 3)
- A199-46, Grade 1
- A200-46, Grade 1
- A213-46, Grade T11
- A158-46T, Grade P11

1.75 Cr-0.75 Si-0.75 Mo steel (Table 4)
A199-46, Grade 3
A200-46, Grade 3
A213-46, Grade T3
A158-46T, Grade P3a
A182-46, Grade F3
2.0 Cr-0.5 Mo steel (Table 5)
A199-46, Grade 4
A200-46, Grade 4
A213-46, Grade T14
A158-46T, Grade P3b
2.0 Cr-1.25 Si-0.5 Mo steel (Table 6)
None
2.5 Cr-0.75 Si-0.5 Mo steel (Table 7)
A199-46, Grade 2
A200-46, Grade 2
2.25 Cr-1.0 Mo steel (Table 8)
A199-46, Grade 6
A200-46, Grade 6
A213-46, Grade T22
3.0 Cr-1.25 Si-0.5 Mo steel (Table 9)
None

TABLE 8. 2.25 per cent Cr, 1 per cent Mo—properties at elevated temperatures*. Composition range covered by specifications (per cent).

C	Mn	Si	P	S	Cr	Mo
0.15 max	0.30/0.60	0.50 max	0.030 max	0.030 max	2.00/2.50	0.90/1.10

Property	Temperature, F							
	700	800	900	1000	1100	1200	1300	1400
ASME Maximum allowable stress (1000 psi)	12.0	11.8	10.0	6.25	3.7	1.95		
Tensile strength (1000 psi)	68.5	66.5	63	53	42.5	32.5	22.5	14.0
Yield strength (1000 psi)								
Elongation (per cent in 2 in.)	23	27	31	36	45	57	66	76
Reduction of area (per cent)	61	65	71	81	90	93	96	99
Creep strength 1 per cent in 10,000 hr (1000 psi)			40.5	*11-16.3* 13	*5.6-9.2* 7.3	*4.2-4.5* 4.4		
Creep strength 1 per cent in 100,000 hr (1000 psi)			22	*6.5-7.6* 7.0	*3.6-4.8* 4.2	*2.2-2.6* 2.4		
Rupture strength 1000 hr—(1000 psi)								
Rupture strength 10,000 hr—(1000 psi)								
Oxidation (weight loss in grams per sq in. after 168 hr in air at the indicated temperatures)	nil	nil	nil	0.03	0.10	0.32	0.65	1.01
Linear thermal expansion (inches per foot—from 70 F to the indicated temperatures		0.066		0.087		0.110		

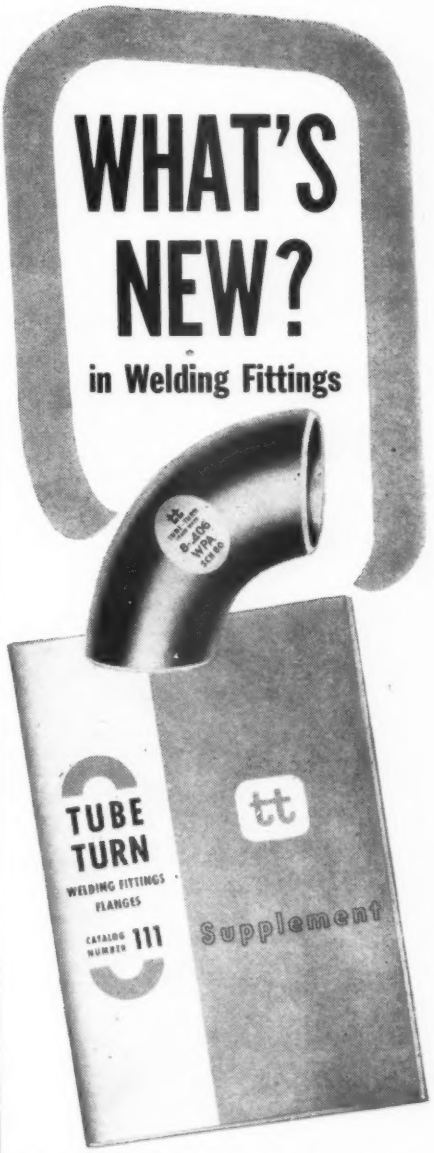
*Values in italics show spread of available data, and accompanying single values are a conservative average of the data. Single values, only, represent limited data.

TABLE 9. 3 per cent Cr, 1.25 per cent Si, 0.5 per cent Mo—properties at elevated temperatures*. Composition range covered by specifications (per cent).

C	Mn	Si	P	S	Cr	Mo
0.15 max	0.50 max	1.0/1.4	0.030 max	0.030 max	2.75/3.25	0.45/0.65

Property	Temperature, F							
	700	800	900	1000	1100	1200	1300	1400
ASME Maximum allowable stress (1000 psi)								
Tensile strength (1000 psi)	70	64	56	47	36.5	27	18	12
Yield strength (1000 psi)				25	21.5	16.5	10	7
Elongation (per cent in 2 in.)				43.5	51	59	71	90
Reduction of area (per cent)				81.5	88	91.5	94	97
Creep strength 1 per cent in 10,000 hr (1000 psi)				8.3	5.0	3.5		
Creep strength 1 per cent in 100,000 hr (1000 psi)				5.4	2.5	1.8		
Rupture strength 1000 hr—(1000 psi)				19	10.5	6.6	4.0	2.2
Rupture strength 10,000 hr—(1000 psi)				15.0	7.2	4.5	2.8	1.2
Oxidation (weight loss in grams per sq in. after 168 hr in air at the indicated temperatures)	nil	nil	nil	0.01	0.01	0.01	0.02	0.04
Linear thermal expansion (inches per foot—from 70 F to the indicated temperatures)		0.065		0.086		0.107		

*Limited data available.



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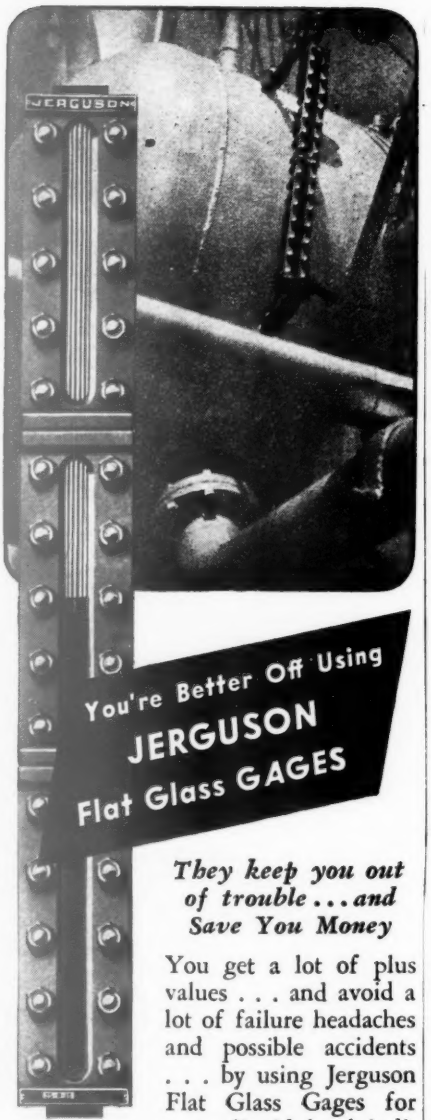

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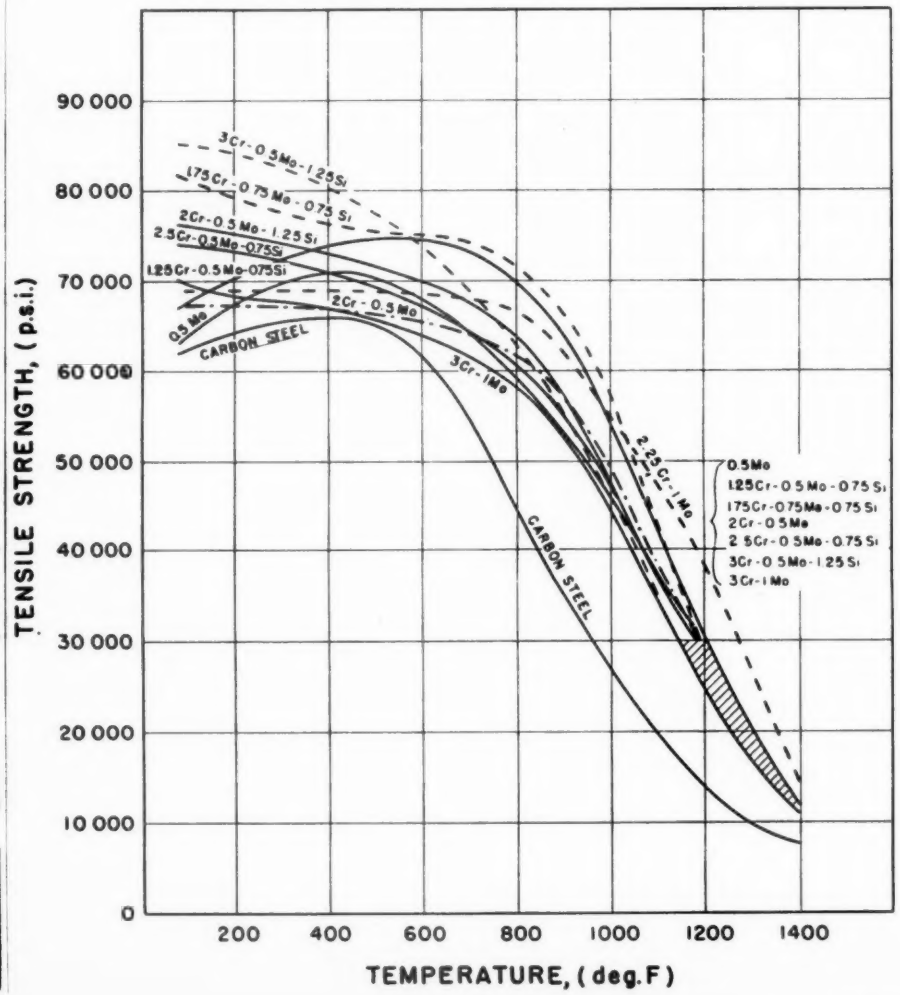
TABLE 10. 3 per cent Cr, 1 per cent Mo—properties at elevated temperatures*. Composition range covered by specifications (per cent).

C	Mn	Si	P	S	Cr	Mo
0.15 max	0.30/0.60	0.050 max	0.030 max	0.030 max	2.75/3.25	0.90/1.10

Property	Temperature, F							
	700	800	900	1000	1100	1200	1300	1400
ASME Maximum allowable stress (1000 psi)	12	11.8	10.0	6.25	3.7	1.95		
Tensile strength (1000 psi)	62.0	59.0	53.0	45.0	35.5	24.5	17.5	11.0
Yield strength (1000 psi)								
Elongation (per cent in 2 in.)	23.5	24.5	31.5	40.0	48.0	57.0	69.0	83.0
Reduction of area (per cent)	64.0	67.5	76.5	82.5	88.0	93.5	98.5	
Creep strength 1 per cent in 10,000 hr (1000 psi)				*10-11* 10.5	*5.5-9* 6.8	4.0		
Creep strength 1 per cent in 100,000 hr (1000 psi)				6.8	4.5	1.5		
Rupture strength 1000 hr—(1000 psi)								
Rupture strength 10,000 hr—(1000 psi)								
Oxidation (weight loss in grams per sq in. after 168 hr in air at the indicated temperatures)	nil	nil	nil	0.02	0.10	0.31	0.63	0.96
Linear thermal expansion (inches per foot—from 70 F to the indicated temperatures)		0.065		0.086		0.107		

*Values in italics show spread of available data, and accompanying single values are a conservative average of the data. Single values, only, represent limited data.

FIG. 1. Tensile strength curve.



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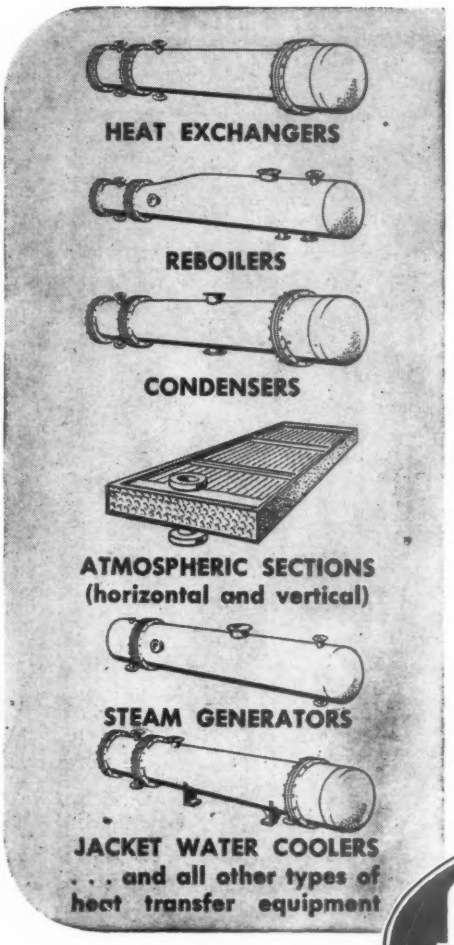

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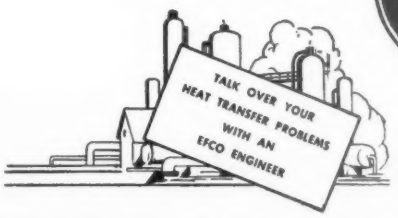

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HOTELS

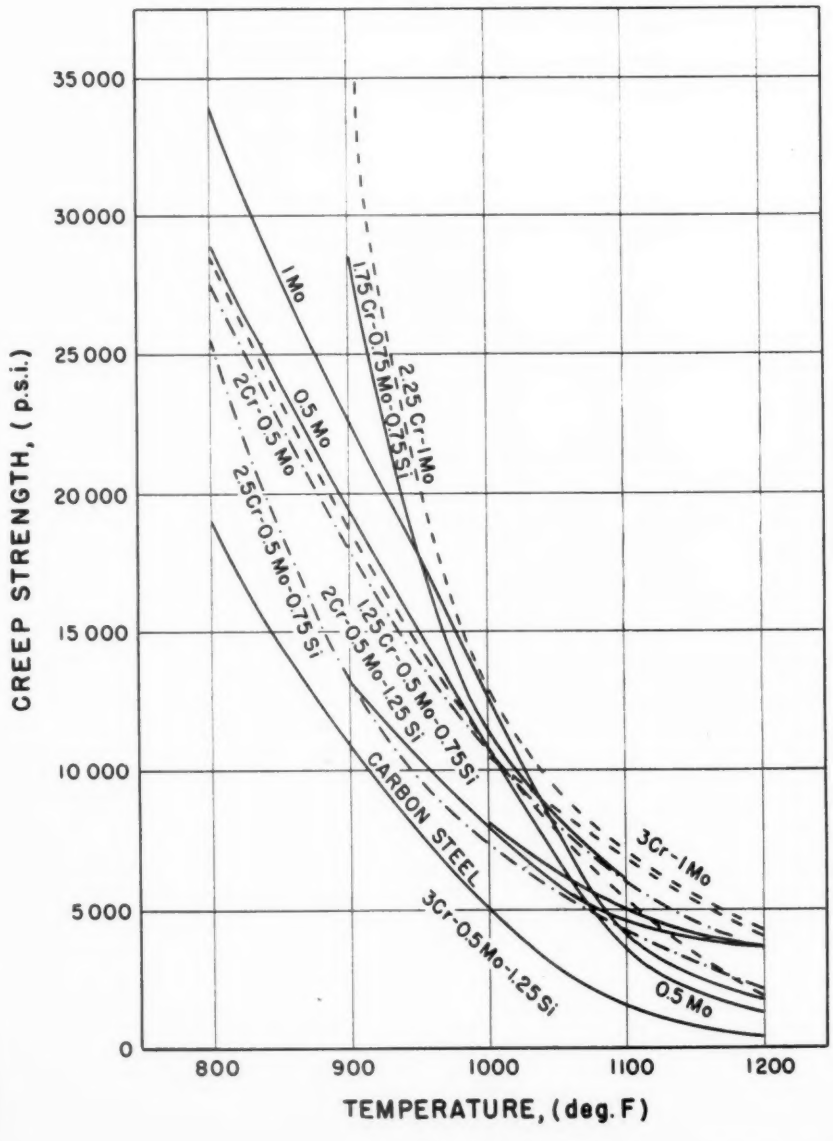
3.0 Cr-1.0 Mo steel (Table 10)
A199-46, Grade 5
A200-46, Grade 5
A213-46, Grade T21

The average tensile, creep, and rupture strengths of these steels at elevated temperatures are shown in Tables 1 to 10. It will be seen from the tensile strength curve, Fig. 1, which covers the entire range from room temperature to 1400 F, that there is little or no decrease of strength from room temperature to 600 to 700 F. Indeed, in the carbon and molybdenum steels, the tensile strength actually increases with increase of temperature from room temperature to 400 to 600 F (the blue brittle range). It is noteworthy that this increase of strength is not apparent in the chromium-bearing steels. Above 700 F, where softening or creep first appears in steel, the strength decreases rapidly, and design of structures to operate above this temperature must be based on creep and rupture strength instead of yield and tensile strength.

Examination of the average creep and rupture curves, Figs. 2 and 3, discloses that the strength of carbon steel is greatly increased by the addition of molybdenum. Below 1000 F, addition of chromium to molybdenum-bearing steel does not generally cause further improvement in strength. Above 1000 F chromium and silicon additions cause some improvement in creep and rupture strength, probably because these elements improve the scaling or corrosion resistance.

Tests have shown that the scaling resistance of carbon steel is not markedly altered by the addition of molybdenum. Small amounts of chromium cause some improvement, whereas increase of the silicon content in the chromium-molybdenum steels to 1.25 or 1.50 per cent causes a large increase in scaling resistance. Scaling tests in steam have shown, however, that silicon does not improve scaling resistance as much as in air. Experience with oil refinery cracking still tubes indicates that chromium contributes somewhat more to corrosion resist-

FIG. 2. Creep strength curves.



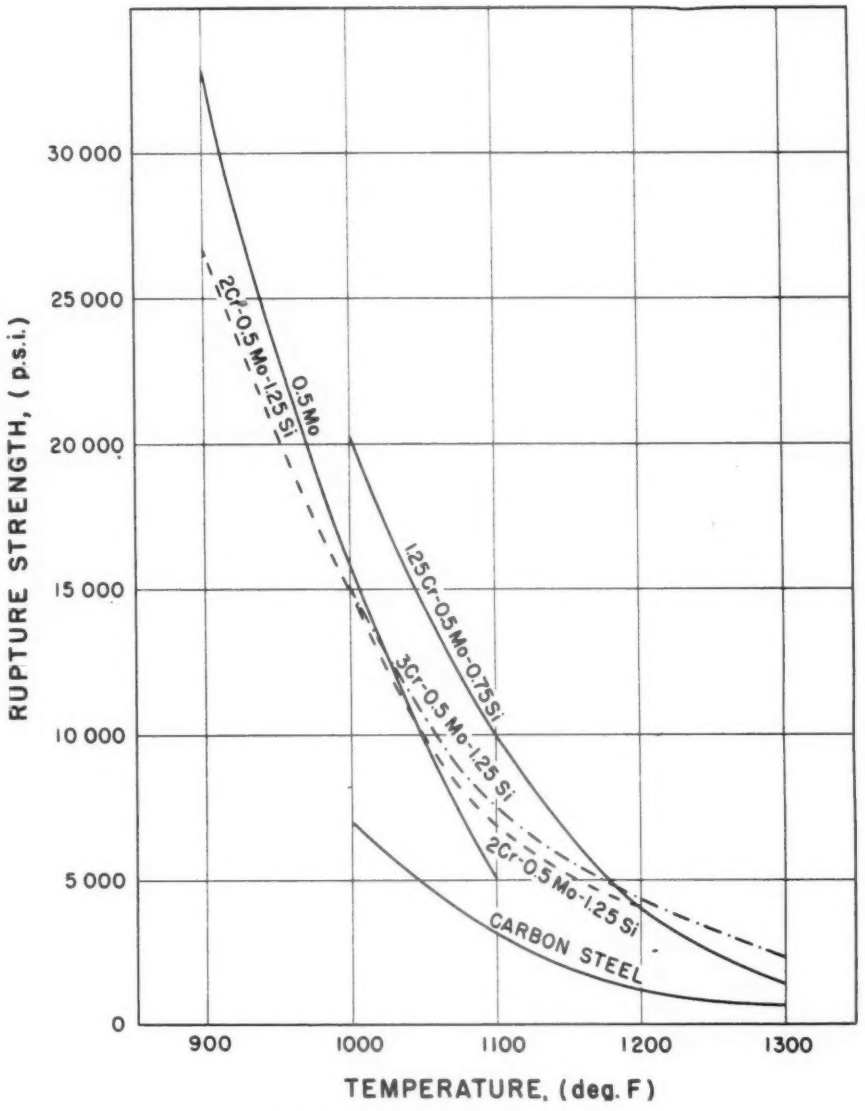


FIG. 3. Rupture strength curves.

ance than was found in the scaling tests in air.

● Bibliography.

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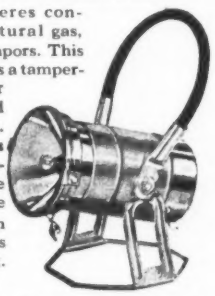

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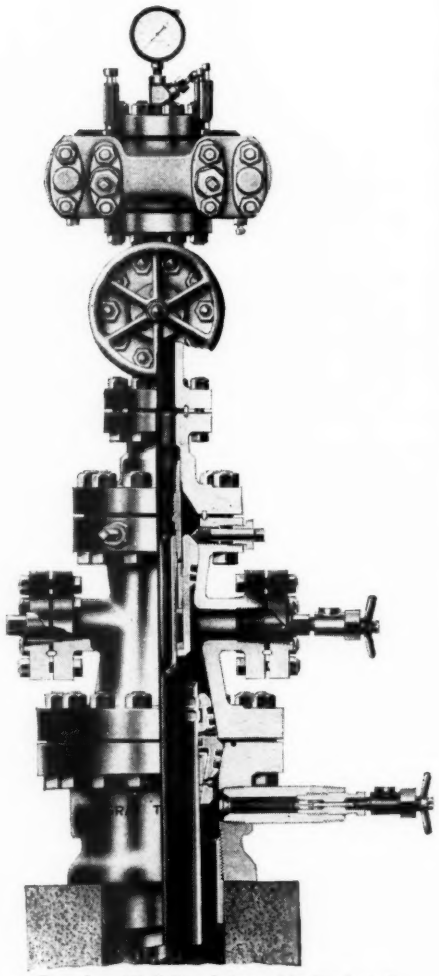

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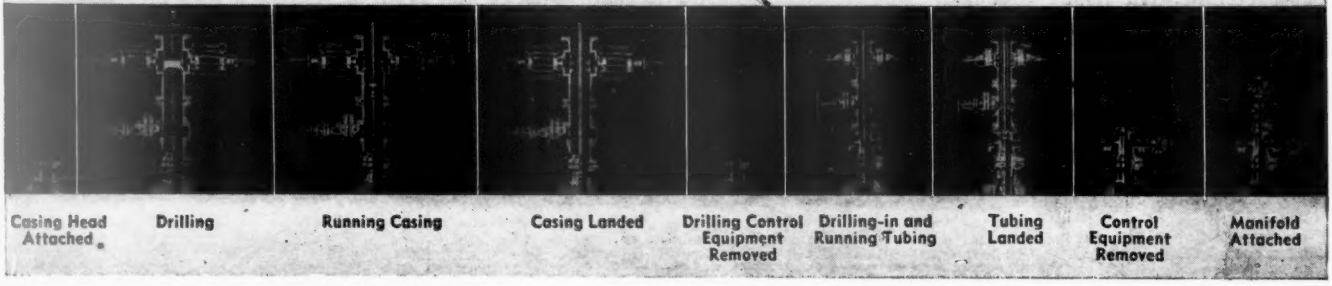

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This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941, issue; 48-60, inclusive, in the June, 1942, issue; 61-72, inclusive, in the June, 1943, issue; 73-79, inclusive, in the January, 1944, issue; 80-82, inclusive, in the April, 1944 issue; 83-85, inclusive, in the July, 1944, issue; 86-88, inclusive, in the October, 1944, issue; 89-91, inclusive, in the January, 1945, issue; 92-94, inclusive, in the April, 1945, issue; 95-97, inclusive, in the July, 1945, issue; 98-100, inclusive, in the October, 1945, issue; 101-103, inclusive, in the January, 1946, issue; 104-106, inclusive, in the April, 1946, issue; 107-109, inclusive, in the July, 1946, issue; 110-112, inclusive, in the October, 1946, issue; 113-115, inclusive, in the January, 1947, issue; 116-118, inclusive, in the April, 1947, isisue; 119-121, inclusive, in the July, 1947, issue; 122-124, inclusive, in the October, 1947, issue.

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Griscom-Russell Co.	(sheet 5) 198	Jan.	P 734.2
Hyatt Bearings Division, General Motors Corporation	(sheet 3) 202	Jan.	P 502.77
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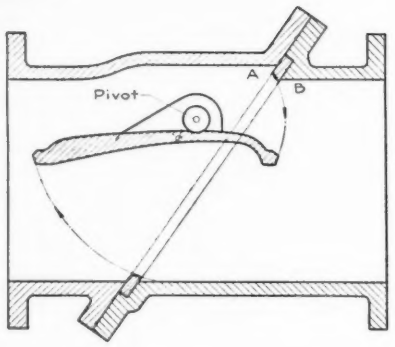

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HEAT TRANSFER COEFFICIENTS OF CONDENSERS, EXCHANGERS, AND REBOILERS

Reboilers—boiling liquids with condensing steam. Actual coefficients obtained in the plant for boiling liquids with condensing steam are given in Table 6. It was impossible to calculate theoretical coefficients because:

1. The boiling film was controlling. As mentioned previously (*see Boiling liquids*) there are no adequate methods for predicting the boiling film coefficients. This is especially true in horizontal reboilers where the degree of boiling would vary with the height of liquid over the individual tubes.

2. The fouling in the reboilers was much greater than in the other exchangers. The high temperatures encountered in reboilers are most conducive to the decomposition of chlorinated hydrocarbons and the polymerization of unsaturated hydrocarbons.

3. In some cases the steam condensate was sub-cooled. Methods (Colburn, et al.[2]) are available for estimating the degree of sub-cooling but these are of little value with the uncertainties mentioned.

The data on reboiler coefficients, however, do show that:

1. A heat flux density of 8,000 to 10,000 Btu/(hr) (sq ft) at a temperature difference of 80 F is a conservative design value for boiling chlorinated hydrocarbons and hydrocarbons in horizontal reboilers. Actual heat flux densities of more than 13,000 at a temperature difference of approximately 100 F were obtained for a clean reboiler but the heat flux density went down to about 9000 after a month of service.

2. Coefficients as high as 575 Btu/(hr) (sq ft) (°F) were obtained in a vertical thermosiphon-type reboiler boiling 35 per cent hydrochloric acid; however, for a similar exchanger and service, test No. 74, a coefficient of only 135 was obtained. There was no apparent explanation for the discrepancy.

3. Fouling caused by the decomposition of chlorinated hydrocarbons can seriously lower heat transfer capacity. For example, Tests 54, 55, and 56 were made on the same reboiler over an interval of several months. Test 54, made when the reboiler was commercially clean gave a coefficient of 66.9, which is what could be expected with the low-temperature difference of 12 F; however, with continued use the coefficient decreased until, in Test 56, it was only 20 with a temperature difference of 96 F.

TABLE 6. Heat transfer coefficients for reboilers.

Test No.	Type	Surface area, sq ft	Fluid flowing in		Heat load, M Btu/hr	Δt °F	Heat flux density, Btu/(hr) (sq ft)	Actual coefficient Btu/(hr) (sq ft) (°F)
			Tube side	Shell side				
54	Shell and tube	550	Condensing steam	Boiling chlorinated hydrocarbon	441	12.0	804	66.9
55					580	25.0	1,055	42.2
56					1,063	96.1	1,934	20.1
57					1,263	46.4	2,295	49.6
58					1,221	52.5	2,220	42.3
59					1,121	64.0	2,040	31.8
60	Shell and tube	104	Condensing steam	Boiling chlorinated hydrocarbon	1,325	91.0	12,730	140.0
61					1,406	91.9	13,500	148.6
62					1,295	103.5	12,440	120.2
63					1,046	105.0	10,060	95.9
64					1,041	107.1	10,010	93.5
65					931	96.1	8,950	93.2
66					529	41.8	5,080	121.6
67					802	48.9	7,700	158.0
68					730	42.0	7,020	167.0
69	Shell and tube	550	Boiling mixture of chlorinated hydrocarbon and catalyst	Condensing steam	995	181.0	1,736	9.6
70					984	67.0	1,787	26.7
71					831	101.0	1,511	15.0
72					803	86.0	1,460	17.0
73					1,080	166.0	1,960	11.8
74	Vertical shell and tube (Karbate)	145.4	20 per cent HCl	Condensing steam	1,086	55.1	7,460	135.7
75	Vertical shell and tube (Karbate)	319	35 per cent HCl	Condensing steam	1,763	11.7	5,520	472.0
76					2,913	16.4	9,130	557.0
77					3,182	18.5	9,975	540.0
78					3,814	20.8	11,950	575.0
79	Shell and tube	217	Hot water	Boiling hydrocarbons	529	57.3	2,435	42.5
80	Shell and tube	217	Hot water	Boiling hydrocarbons	804	42.0	3,700	88.4

● **Discussion of results.** The actual and calculated heat transfer coefficients given in Tables 2-5 are compared in Fig. 2 by plotting the calculated coefficients against the actual coefficients. These data were analyzed also by the method of least squares which showed that 95 per cent of the time the maximum absolute deviation is about 11 Btu/(hr) (sq ft) (° F). The percentage deviation will vary depending on the size of the heat transfer coefficient, being as high as 100 per cent for a heat transfer coefficient of 11 Btu/(hr) (sq ft) (° F). However, for heat transfer coefficients more than 35 Btu/(hr) (sq ft) (° F) the deviation between the actual and calculated is less than 30 per cent and this is within the accuracy of the methods for calculating theoretical heat transfer coefficients. (For example the Dittus and Boelter equation has a reliability of ± 20 per cent and most of the other equations for individual films have a larger uncertainty than this.)

Eight of the tests (No. 16, 19, 30, 31, 32, 33, 34, and 37) had an absolute deviation greater than 11 Btu/(hr) (sq ft) (° F) and the least squares treatment indicated that these tests should be discarded; however, tests No. 19, 31, 32, 34, and 37 had a percentage deviation of less than 30 per cent which is within the accuracy of the method of calculation and therefore, were good tests even though the statistical treatment indicated otherwise. Tests 16 and 33 were believed to be in error due to the errors in the test data inasmuch as other tests on the same exchangers gave acceptable comparisons. When test No. 30 was made the condenser had been in service several years without cleaning and, therefore, was badly fouled on the water side. In addition, the unit was in such a service that foaming from the evaporating unit resulted in undue fouling on the condensing side.

The percentage deviations of the actual from the calculated coefficients were calculated and are shown in Tables 2-5. Except for the three tests, No. 16, 30, and 33, discarded as just mentioned, only five tests gave percentage deviations greater than 30 per cent and as expected these were all for heat transfer coefficiencies below 30 Btu/(hr) (sq ft) (° F). The maximum per centage deviation obtained (exclusive of the discarded points) was 55 per cent.

NOTE: References and nomenclature are shown on Sheet 5 of this series of tables.

Taken from the article "Predicting commercial heat transfer coefficients," by E. P. Breidenbach and H. E. O'Connell, Ethyl Corporation, published in *AIChE Transactions*, Vol. 42, Nos. 5-6, October-December, 1946, and in *The Petroleum Enginer*, Reference Annual, 1947, pages 191 to 198, inclusive.

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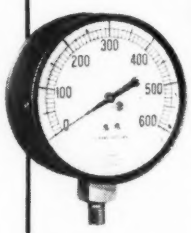

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INTERPRETATION OF WELL TEST DATA IN GAS-CONDENSATE FIELDS

Retrograde curves are shown in Figs. 1 to 3, in which the liquids that have accumulated in the cell are plotted in G.P.M.† against pressure. The G.P.M. scale is presumed to correspond to the cumulative losses that will have occurred by condensation in the reservoir at each successive pressure reduction. The place at which the cumulative losses reach the maximum is called the retrograde point. This reversal point separates the retrograde from the normal region. In the retrograde region, reduction of pressure causes condensation, whereas in the normal region reduction of pressure causes vaporization and some of the liquids deposited in the retrograde region are revaporized.

Figs. 1 and 2 show tests by both flash and differential separation on the same gases. In all of the comparative tests known to the writer, more condensation has been shown by flash separation, though by varying amounts, Fig. 2 showing the least difference. Fig. 3 shows the average differential retrograde curves for three gases of different initial G.P.M. These three curves show how much more liquid is condensed from the richer gases both in quantity and in percentage of the initial content.

†Gallons of natural gasoline per M cu ft of gas.

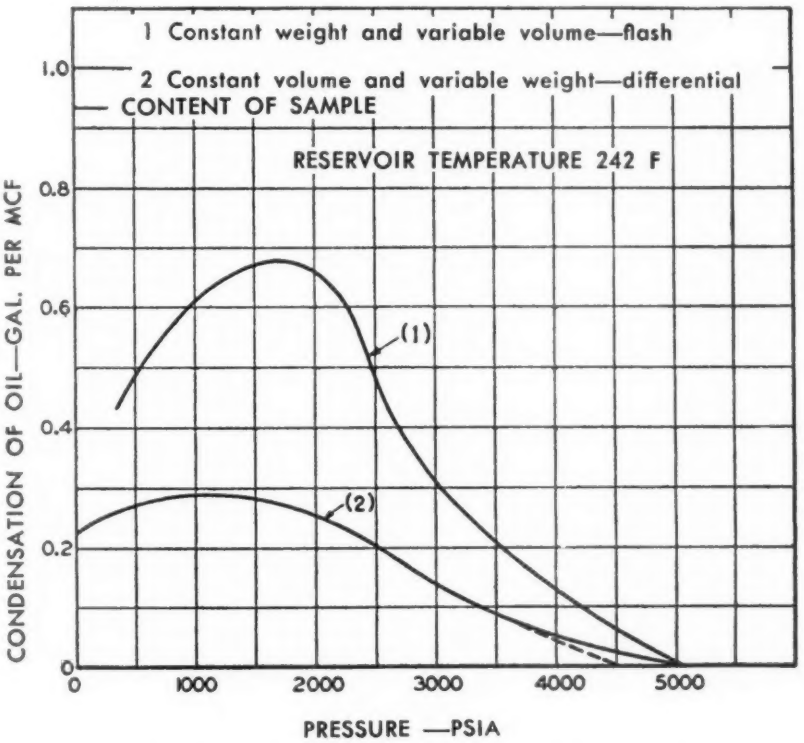


FIG. 1. Comparison of flash and differential retrograde curves for same gas. Concave types and large differences.

Taken from the article, "Interpretation of Well Test Data in Gas-condensate Felds," by James O. Lewis that was presented before American Institute of Mining and Metallurgical Engineers, Chicago, Illinois, February 1946. Published in *Petroleum Technology*, July, 1946. Published in *The Petroleum Engineer*, September, 1947, pages 180 to 202, inclusive.

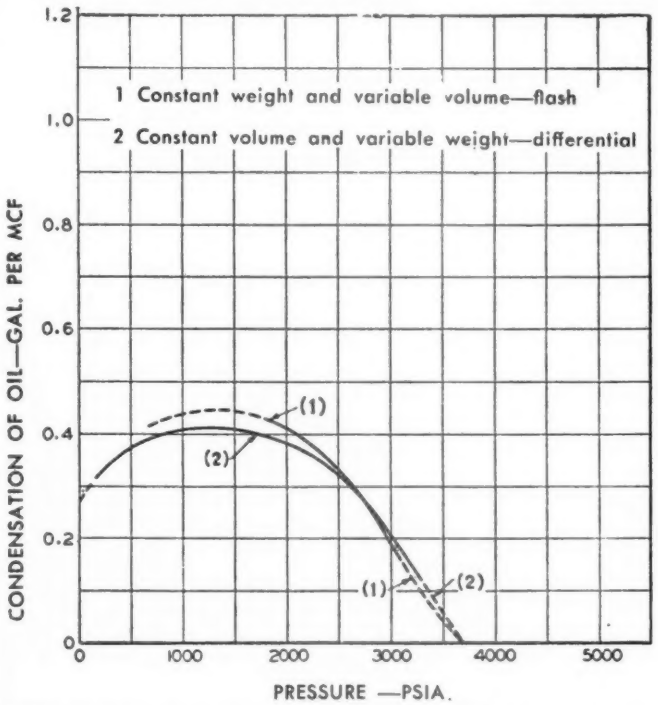


FIG. 2. Comparison of flash and differential retrograde curves for the same gas. Convex types and small differences.

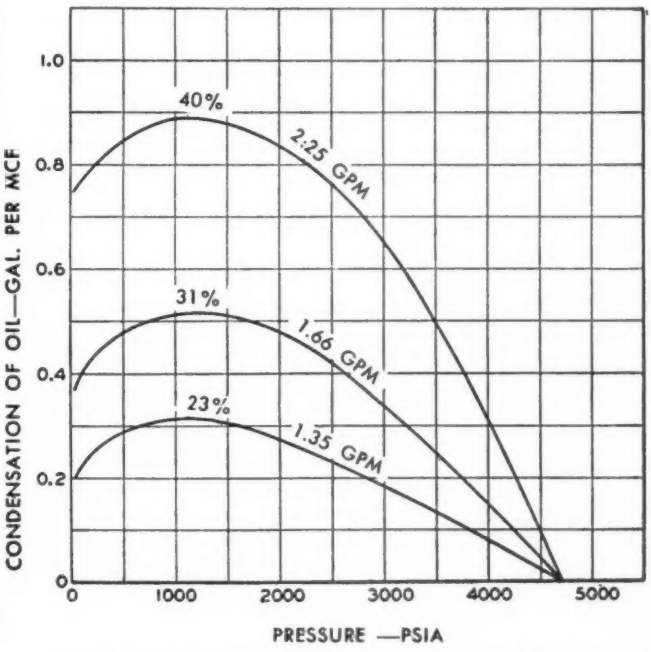
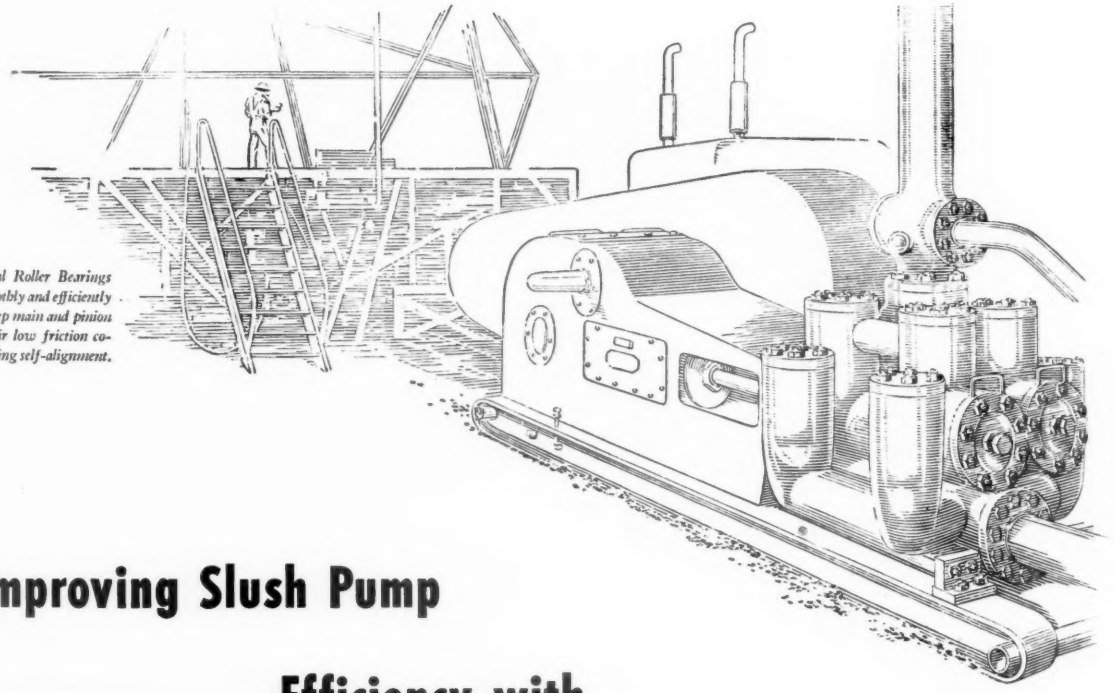


FIG. 3. Comparison of difference in curves for three gases of different G.P.M. in the same reservoir.



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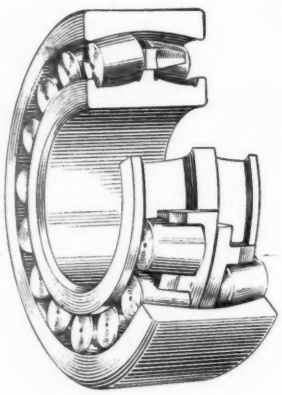

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HEAT TRANSFER COEFFICIENTS OF CONDENSERS, EXCHANGERS, AND REBOILERS

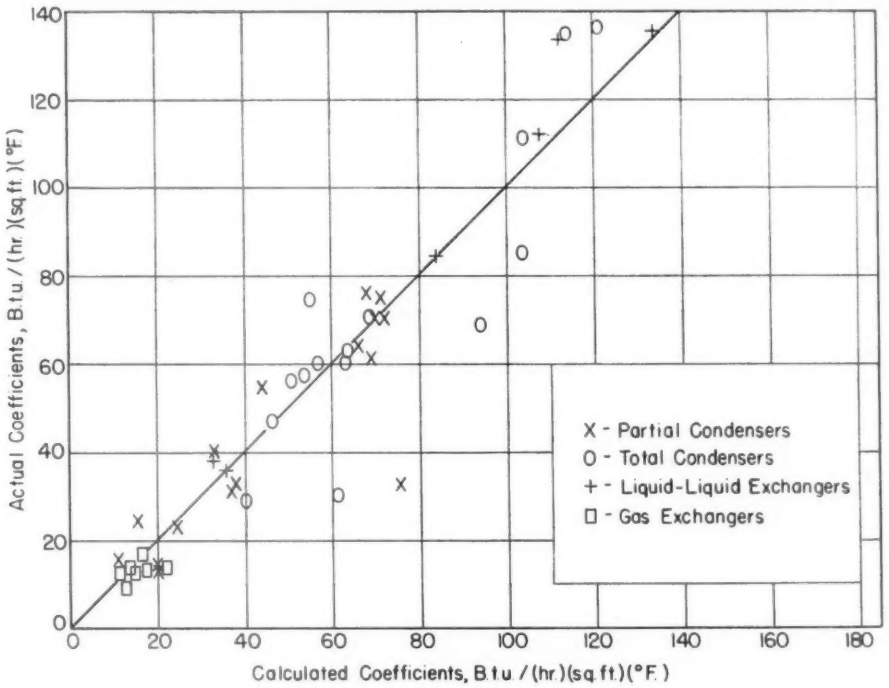

FIG. 2. Comparison of calculated and actual coefficients.

● **Conclusions.** Commercial heat transfer coefficients can be calculated with engineering accuracy by methods available in the literature for the following types of exchangers:

1. Partial condenser;
2. Total condenser;
3. Liquid-liquid exchangers;
4. Gas exchangers,

for materials having the same fouling characteristics as water, chlorinated hydrocarbons, and low boiling hydrocarbons. For other systems, the coefficient can be calculated if the fouling factor is known; however, for systems with a high fouling factor, the coefficient cannot be predicted with high accuracy since the fouling film, which even at the best has a high uncertainty, may be the controlling film.

The overall heat transfer coefficient for reboilers (boiling liquid with condensing steam) cannot be calculated, mainly because the boiling film cannot be determined. For design purposes, a heat flux density of 8,000 to 10,000 Btu/(hr) (sq ft) (° F) at a temperature difference of 80 F seems to give conservative values for boiling chlorinated hydrocarbons, low boiling hydrocarbons and hydrochloric acid solutions.

● **Nomenclature**

A = area of heating surface, sq ft,
b = wetted perimeter, ft,
c_p = specific heat at constant pressure, Btu/(lb) (°F).
D = diameter, ft; D_e, equivalent diameter; D_2, outside diameter; D_1 and D_2, diameter of annulus,
F.C.S. = free cross-section open to flow,
G = mass velocity, lb/(hr) (sq ft of cross-section); $G_{max.}$ is the value based on the minimum area available for fluid flow; G_c refers to condensate; G_v to vapor,
h = coefficient of heat transfer, Btu/(hr) (sq ft) (°F); h_f is coefficient of a scale or deposit,
j = a product of dimensionless terms, $j = (h/c_pG)(c_p\mu/k)^{2/3}$,
k = thermal conductivity, Btu/(hr) (sq ft) (°F per ft),
L = thickness of exchanger tube, ft,
N.C.S. = net cross-section open to flow,
q = heat transferred, Btu/hr,
S = cross-section open to flow, sq ft,
T.R. = temperature range between inlet and outlet, ° F,
U = overall coefficient of heat transfer. Btu/(hr) (sq ft) (°F),
W = linear dimension of baffle, ft,
x = lateral dimension of baffle, ft,
y = distance between baffles, ft,
z = diagonal dimension between baffles, ft,
Δt = temperature difference, °F; Δt_m is logarithmic mean temperature difference,
ρ = density, lb/cu ft,
ρ_l = density of liquid,
ρ_v = density of vapor,
μ = viscosity.

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Taken from the article "Predicting commercial heat transfer coefficients," by **E. P. Briedenbach** and H. E. O'Connell, Ethyl Corporation, published in *AIChE Transactions*, Vol. 42, Nos. 5-6, October-December, 1946, and in *The Petroleum Engineer*, Reference Annual. 1947, pages 191 to 198, inclusive.

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INTERPRETATION OF WELL TEST DATA IN GAS-CONDENSATE FIELDS

Evidence on the effects of changing flow rates and of the short and long-time effects are shown in Figs. 4 and 5. The data for these graphs were obtained from a field where each well was being produced through a full-scale separator. The G.P.M. was determined by gauging the separator liquid, metering the gas and determining the contents of the separator gas by charcoal absorption.

The data from which the curves in Fig. 4 were derived were obtained in connection with back-pressure tests on the wells. After each change in flow rate, the well was allowed to stabilize at least 48 hr. The arrows indicate the order of the tests. The four records are representative of the results obtained in testing a number of wells. Though generally the wells showed lower G.P.M. at high flow rates, there is much erraticism, and it is obvious how deceptive changing flow rates can make G.P.M. tests. In this field 48 hr was not sufficient to establish new equilibriums; however, others who have tested wells in other fields report no significant change in G.P.M. at varying flow rates.

The long-term effects are shown in the records of two wells in Fig. 5. Each well shows the general loss in G.P.M. that is to be expected from pressure losses. Superimposed on this trend; the effects of changed flow rates are clearly evident though the data do not permit making quantitative estimates. In the upper graph, a drop in flow rate from 3100 to 1700 M cu ft corresponds to a marked increase of G.P.M. over the previous trend. In the lower graph, a drop in the flow rate from 7900 to 3000 M cu ft corresponds to an actual increase from 2.85 to 3.90 G.P.M. This was followed by an increase in flow rate, which coincides with a decrease in G.P.M.

As high flow rates reduce the current G.P.M. to an important degree, consideration should be given to the overall effect on condensate recovery during the life of the reservoir. It can be reasoned that in a depleting operation the wells will have to go through all the stages of pressure reduction past the retrograde pressure to final commercial exhaustion in the normal region, and that by high flow rates the well merely goes through these stages sooner, and that the final results will be the same. In a cycling operation, low flow rates will cause less pressure reduction at the well by the time dry gas reaches it, hence there is more reason to believe that low flow rates might be beneficial. The writer has no field evidence to support an opinion under either method of operation.

Taken from the article, "Interpretation of Well Test Data in Gas-condensate Felds," by James O. Lewis that was presented before American Institute of Mining and Metallurgical Engineers, Chicago, Illinois, February 1946. Published in *Petroleum Technology*, July, 1946. Published in *The Petroleum Engineer*, September, 1947, pages 180 to 202, inclusive.

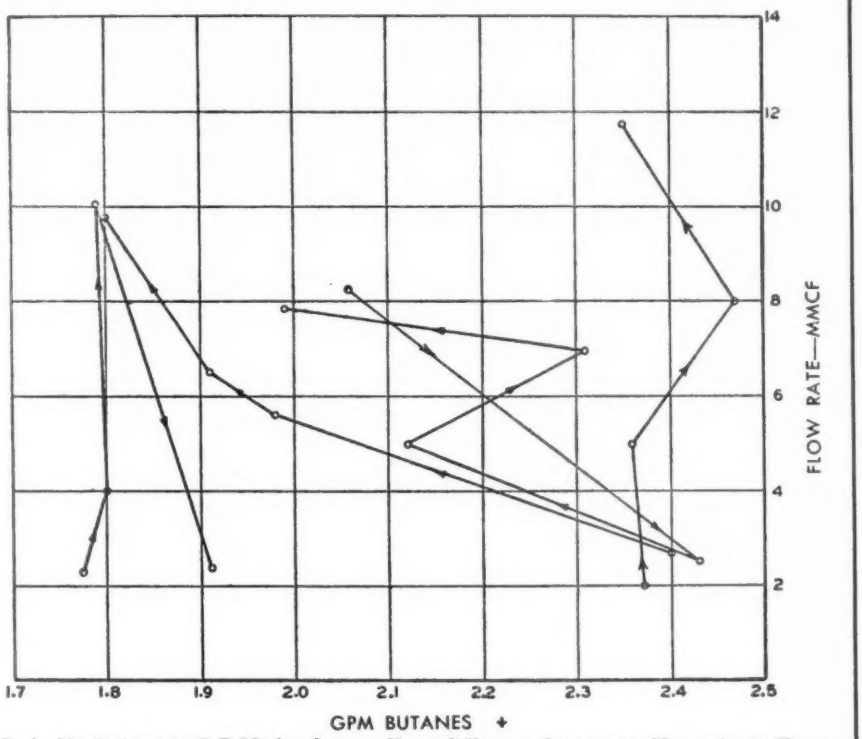

FIG. 4. Variations in G.P.M. for four wells at different flow rates. Short time effects.

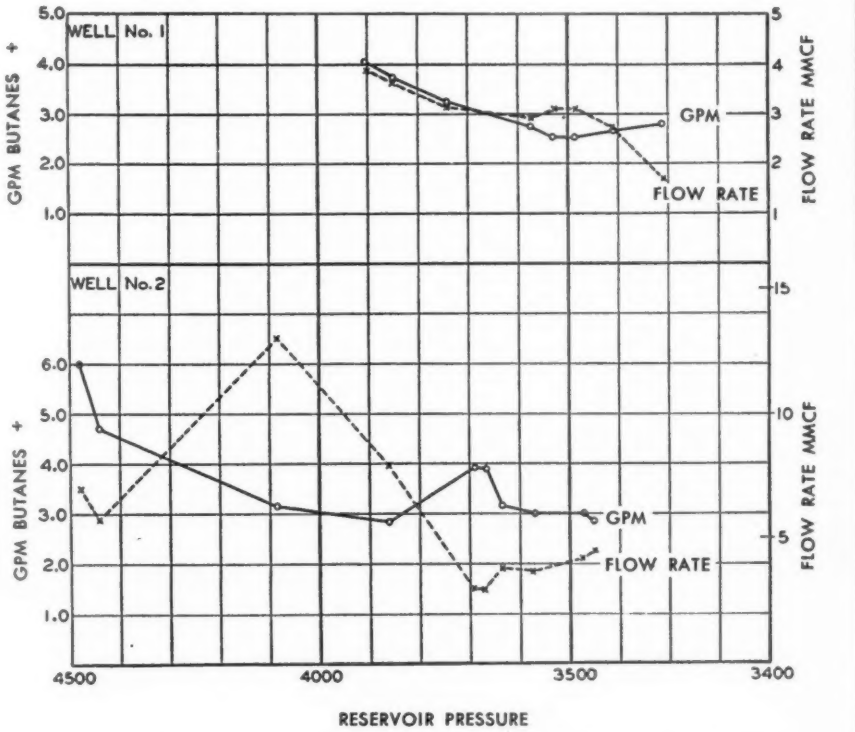

FIG. 5. Long time effect on G.P.M. by changing flow rates.

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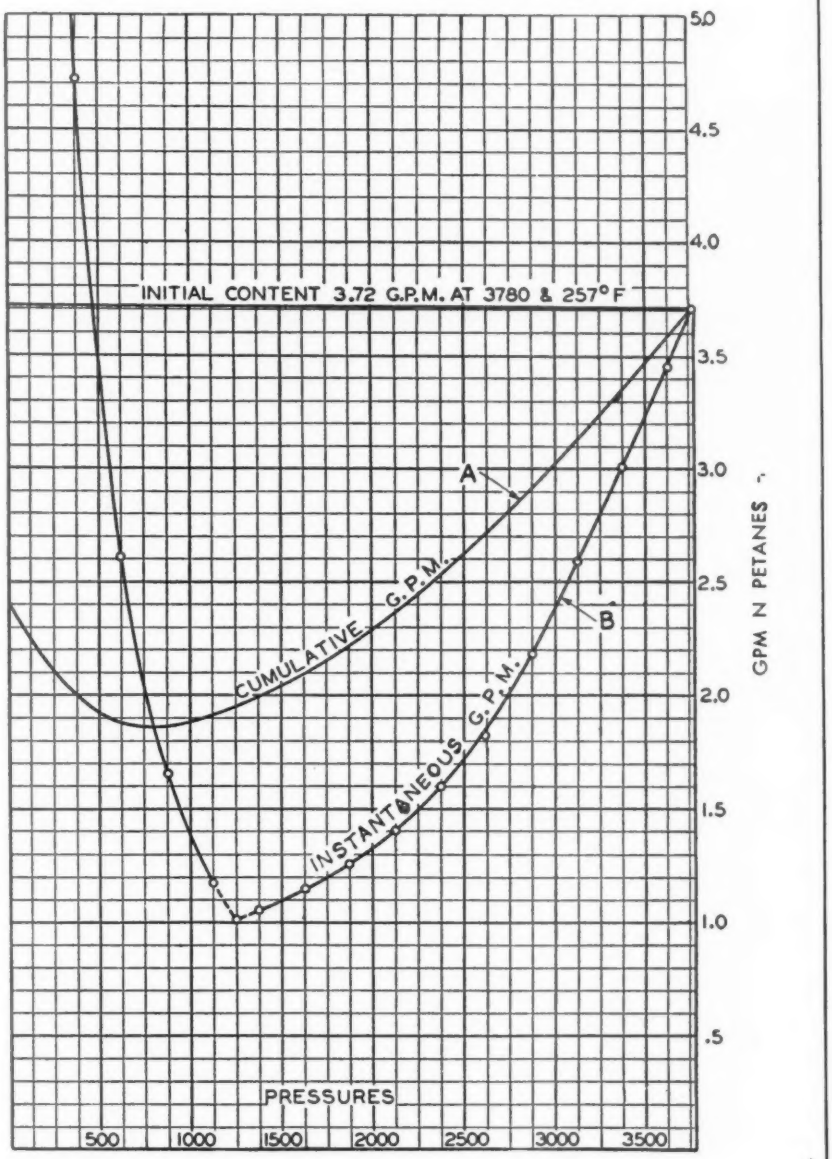
INTERPRETATION OF WELL TEST DATA IN GAS-CONDENSATE FIELDS

● **Interpretation of retrograde test data.** To compare field data with the laboratory data, it is necessary that they represent the same composition and that both show either cumulative or instantaneous G.P.M. McAllister[6] has shown what proportion of the condensates in the test apparatus can consist of hydrocarbons lighter than pentane. Furthermore, the well or plant records usually are a series of instantaneous G.P.M. or rates, whereas the liquids deposited in the cell show the cumulative loss or, when converted into recovered G.P.M., show the average G.P.M. up to each stage in pressure reduction.

Fig. 6 is based upon McAllister's curve for n-pentanes plus, shown in his Fig. 2, which is the cumulative retrograde condensation by differential liberation of a gas sample from a California field. Curve A, Fig. 6, shows McAllister's curve converted to G.P.M., the cumulative loss in n-pentanes plus being shown above curve A and the cumulative recovery below. Curve B shows the instantaneous G.P.M. at successive pressures which was computed from Curve A. Curve B corresponds to the usual record of G.P.M. well tests plotted against pressure. At 2500 psi curve A shows that the average content of the gas so far produced had been 2.62 G.P.M., whereas, curve B shows that the gas being produced currently had 1.72 G.P.M.

Curve B conveys quite a different impression than the usual cumulative retrograde curve. The decline in G.P.M. is much faster in the retrograde region and the pickup in the normal region is seen to be much larger, and at low pressure the gas will be richer than it was initially. This indicates that much pentane and some of the heavier hydrocarbons will be volatilized and recovered at low pressures, and because of the increasing richness of the gas, the wells may profitably be produced to relatively low pressures. The condensates recovered in the normal region can be expected to be nearer natural gasoline in composition. The G.P.M. at low pressures will be greatly influenced by reservoir temperatures, and the gas should become richest in the deep sands with higher temperatures. The writer has no field data showing whether or not G.P.M. does increase in the manner predicted by the rate curves computed from retrograde tests.

FIG. 6. Cumulative and instantaneous G.P.M. retrograde curves calculated from McAllister's Fig. 2.



The two legs of curve B, Fig. 6, are shown as probably meeting at an acute angle at a higher pressure than the conventional retrograde point shown on the cumulative curve A. Plots made similarly from some other retrograde curves indicate the same thing whereas others show a rather sharp curvature. It would appear that the transition from the retrograde to the normal region may be through a point and that it occurs at a higher pressure than the retrograde point taken from the cumulative curve.

Should further information prove that retrograde condensation follows a definite mathematical equation that is graphically expressed as a straight line on logarithmic paper, it will provide a useful tool for field and laboratory use.

Taken from the article, "Interpretation of Well Test Data in Gas-condensate Felds," by James O. Lewis that was presented before American Institute of Mining and Metallurgical Engineers, Chicago, Illinois, February 1946. Published in *Petroleum Technology*, July, 1946. Published in *The Petroleum Engineer*, September, 1947, pages 180 to 202, inclusive.

NOTE: References are shown on the last sheet in this series of tables.

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HEAT TRANSFER AND DESIGN OF PACKED TUBE AIR HEATERS

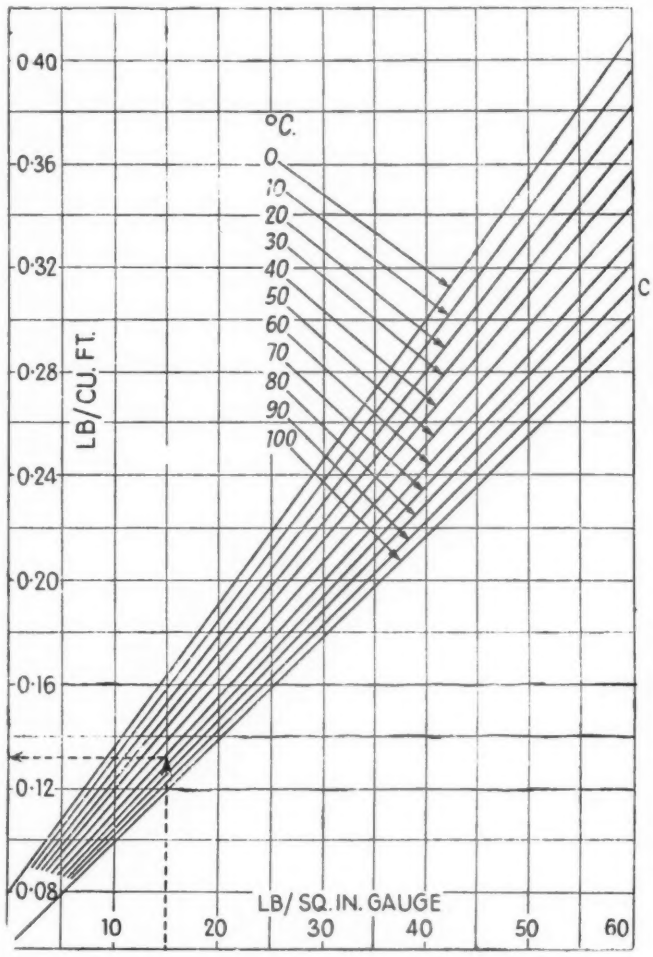


FIG. 1 (left). Density of dry air v pressure at various temperatures.

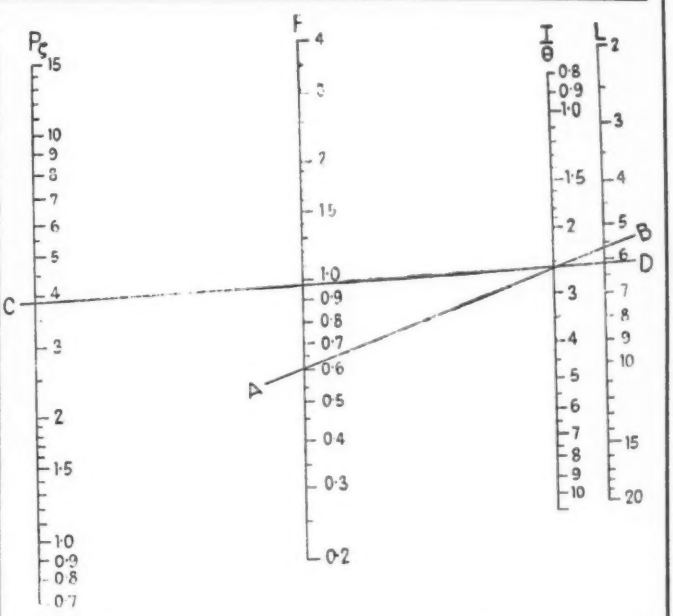


FIG. 2 (above). Nomograph for the simultaneous solution of equations.

The packed tube heat exchanger is only about one-eighth the length of the plain tube apparatus for equal throughput. This is due to the greater heat transfer rate between the air and the tube surface. The laws governing pressure drop and heat exchange in packed tubes have been very fully investigated by Chilton and Colburn*, and if all types and sizes have to be considered it is necessary to refer to the original work.

Many of the heaters required for petroleum practice are relatively small, and for them the writer has prepared a simplified and approximate system for making the necessary calculations.

This system will give sufficient accuracy for practical purposes over the limited range of conditions stipulated. The method of calculation applies to exchangers utilizing a 2-in. diameter steam-heated tube packed with any material of 0.5 in approximate average diameter where the average temperature of the air in the tube does not exceed 200° C and the quantity of free air required is not less than 1/70 cu ft per sec. A 2-in. tube has been selected since larger diameters reduce the heat transfer rate, and if compressed air is available the pressure is usually sufficient to give ample flows for most requirements with this size of tube.

*"Heat Transfer and Pressure Drop in Empty, Baffled and Packed Tube." *Ind. and Eng. Chem.*, 1931, 23, 910-923.

Calculations of Heater Dimensions

1. From the steam condensation temperature T_s and the required air outlet temperature T, the value of T divided by the log. mean temperature difference θ can be calculated from the formula

$$T/\theta = 2.3 \log[T/(T_s - T)]$$

2. Air inlet and outlet pressures and inlet (assume 0° C) and outlet temperatures are known. The average density ρ of the air in the tube can therefore be determined from Fig. 1 with the aid of the arithmetic mean air temperature and pressure.

3. The average density of the air in the tube (lb per cu ft) is multiplied by the air inlet pressure (psig) and thus the value of $P\rho$ obtained.

This value is marked on the line $P\rho$ of Fig. 2.

4. Using the relevant point on the line T/θ (Fig. 2) as a pivot the length of the heater can be determined for varying flows by means of a ruler.

Lining up to the marked point on the $P\rho$ line gives the maximum flow that can be obtained under the given conditions. This value for $P\rho$ must not be exceeded but it need not be equalled, as in practice this would only amount to throttling the air inlet valve to the desired flow.

If the maximum flow is still below the desired figure, then it can be seen from Fig. 2 that the air inlet pressure must be higher, the air outlet temperature lower, or the tube wall temperature must be increased. The last two factors will give a greater flow by allowing a reduction in tube length.

For values outside the range of the nomograph, recourse must be had to the original simplified equation 8 and 14. It is considered, however, that this graph covers the range for which it is advantageous to use a packed tube air heater.

● **Example**

Given, Air pressure available P = 30 psig.

Steam condensation temperature T_s = 130 C.

Required, Air outlet temperature T of 120 C.

To calculate, (*a*) Length of packed tube to give a flow F of 0.6 cu ft per sec. (*b*) Maximum possible air flow F and corresponding tube length L.

a) $T/\theta = 2{\cdot}3 \log[T_s/(T_s - T)]$
$= 2{\cdot}3 \log[130/(130 - 120)]$
$= 255$

Mark 2·55 on the T/θ line of Fig. 2.
Average air temperature = 60 C approx.
Average air pressure = 15 psi approx.
∴From Fig. 1, average density of air in tube

$\rho = 0{\cdot}132.$
$\therefore P\rho = 30 \times 0{\cdot}132 = 3{\cdot}96.$

Mark 3·96 on the $P\rho$ line of Fig. 2 and draw line AB (flow of 0·6 cu ft per sec.).

∴From line L tube length required = 5½ ft.

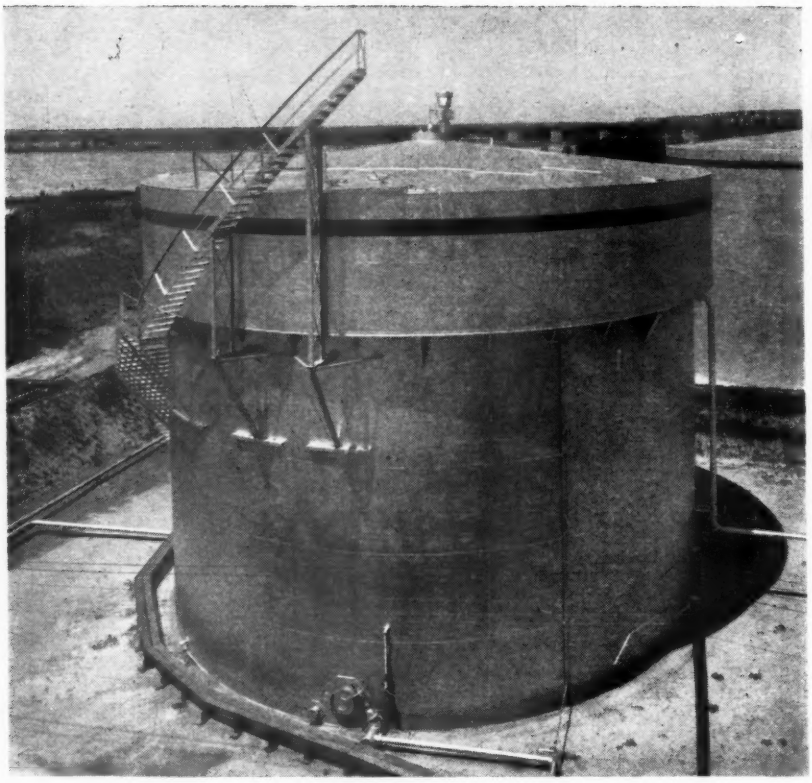
(*b*) Draw line CD, from which it can be seen that for the above conditions:

Maximum possible flow = 0·98 cu ft per sec and tube length required for maximum flow = approximately 6 ft.

Taken from P. H. Moore's article in *Petroleum*, January, 1946, published by Leonard Hill, Ltd., London.

the HORTON LIFTER ROOF

Prevents Evaporation Losses at Pure Oil Company's New River Terminal at Memphis, Tennessee

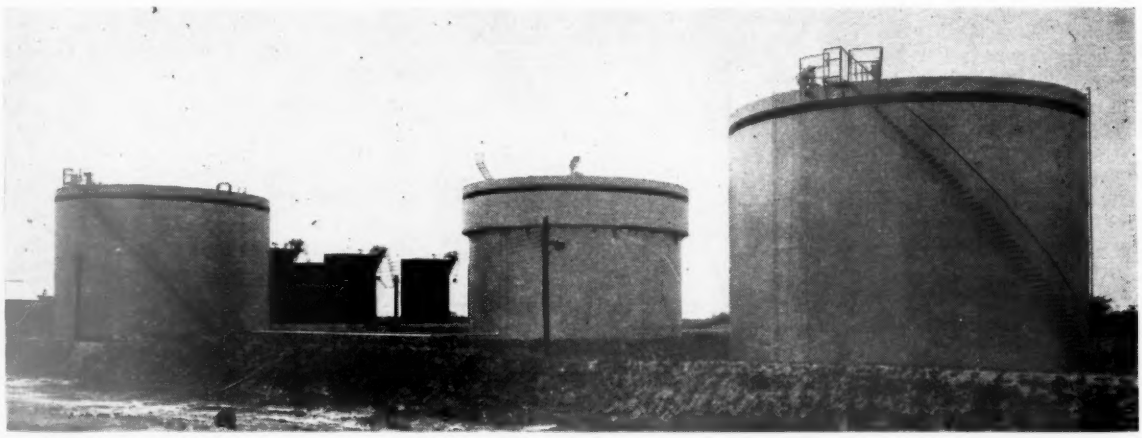


Storage facilities for gasoline and kerosene at the Pure Oil Company's Memphis, Tennessee, terminal consist of three 24,000-bbl. Horton tanks, 60 ft. in diam. by 48 ft. high. Two of these tanks have cone roofs and the third has a Horton Lifter Roof. The lifter roof reduces evaporation losses from the tank on which it is installed and also from one of the cone-roof tanks which is connected to it.

The Horton Lifter Roof reduces vapor loss through the roof vents by providing an expansible vapor space which allows the air-vapor mixture above the stored liquid to expand and contract. When rising temperature causes the air vapor mixture in the lifter-roof tank, and the cone-roof tank connected to it, to expand, the roof moves upward. When the vapor contracts, the roof rides back down on the vapor.

The rim of the Horton Lifter Roof extends downward into a trough filled with a sealing liquid which allows the roof to move up and down and still maintain a gas-tight seal. This movement of the roof reduces breathing losses. The lifter roof also utilizes any surplus capacity to reduce filling losses.

Horton Lifter Roofs are particularly recommended for use on standing storage or slow working tanks. Write our nearest office for further details.



Above: Close-up view of the tank with the Horton Lifter Roof.

Left: The three 24,000-bbl. Horton tanks at the Pure Oil Company terminal. The one in the center has a Horton Lifter Roof and is connected to the cone-roof tank at the left.

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HEAT TRANSFER AND DESIGN OF PACKED TUBE AIR HEATERS

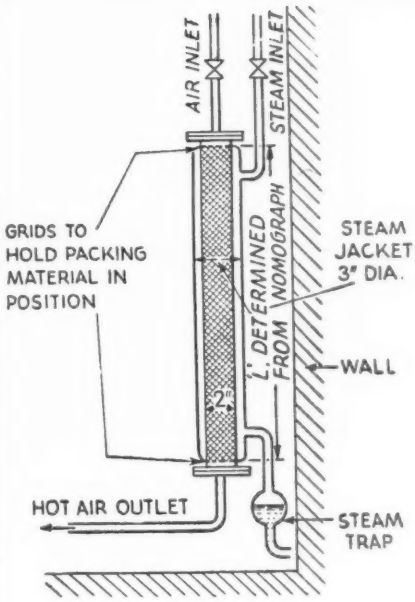

FIG. 3. Layout of heater.

Theory

The transitional point between viscous and turbulent flow is given as:

$D_\rho G/\mu = 0{\cdot}32$ to $0{\cdot}64$ . . . (1)

Where:

D_ρ = particle diameter in inches.
G = mass velocity of the flowing gas in lb/sq ft/sec (based on the tube),
μ = viscosity of the gas in centipoises.

In order to find the limiting value of this expression, it is first necessary to determine the value of Dp. Pebbles screened to ½-in. and air viscosity of 0.0258 centipoise at 200 C are assumed. Putting the above values in equation 1 and equating to unity (the latter giving a reasonable factor of safety) we can find the minimum value of G that gives certainty of the flow being in the turbulent range. ∴ $G = 1{\cdot}0 \times 0{\cdot}0258/0{\cdot}5 = 0{\cdot}0516$ lb/sq ft/sec.

For turbulent flow of gases in packed tubes, the pressure drop is given as:

$\Delta P_\rho = 0{\cdot}082\ A_f \mu^{0.15} LG^{1.85}/D\rho^{1.15}$ (2)

Where:

ΔP = Pressure drop in psi,
A_f = Wall factor.
L = length of the packed tube in ft,
ρ = average density of flowing gas in lb/cu ft.

Other units are as defined for equation 1.

The wall factor A_f depends on the value of particle diameter divided by tube diameter. For the example chosen, this ratio is equal to 0·25, which according to Chilton and Colburn gives a wall factor of 0·575.

Substituting the above values of A_f, μ (as determined for equation 1), and Dp in equation 2, and simplifying we get:

$\Delta P_\rho = 0{\cdot}06LG^{1.85}$ . . . . (3)

For a 2-in. diameter tube $G = 144W/\pi$ . . . . . (4)

Where:

W = lb of air flowing per sec.

Further $W = 0{\cdot}08\ F$ . . . . (5)

Where:

F = flow of air at N.T.P. in cu ft/sec.

∴ Substituting the value of W from equation 5 in equation 4, and simplifying, get:

$G\ 3{\cdot}66\ F$ . . . . . (6)

Also ΔP is equal to the pressure drop in psig, and as the heater is required to discharge at atmospheric pressure (*i.e.*, O psig) the pressure drop will be equal to the air inlet pressure minus discharge pressure—*i.e.*,

$\Delta P = P - O = P$ . . . . . (7)

Substituting values of G and ΔP from equations 6 and 7 in equation 3 and simplifying, we get:

$P_\rho = 0{\cdot}66LF^{1.85}$ . . . . . (8)

Where:

P = air inlet pressure in psig.
L = length of packed tube in ft,
F = flow of air at NTP in cu ft per sec,
ρ = average density of the air in tube in lb/cu ft.

Heat transfer

In a packed tube, the heat transfer coefficient from w ll to flowing air is, according to Chilton and Colburn, given by:

$h = {}_aG^{0.83}/3{,}600$ . . . . . (9)

Where:

h = heat transfer coefficient in P.C.U.'s per sq ft per sec per °C mean temperature difference,
a = a constant depending on the value of the particle diameter divided by tube diameter,
G = mass velocity as defined in equation 1.

The value of a for a 2-in. diameter tube packed with particles of ½ in. diameter is given by Chilton and Colburn as equal to 28.

Substituting the value for h in the standard heat transfer equation $Q = hA\theta$ we get:

$Q = 28G^{0.83}\ A\theta/3{,}600$ . . . (10)

Where:

Q = heat transferred in P.C.U.'s per second,
A = area of tube in contact with packing material in sq ft,
θ = log. mean temperature difference between tube wall and flowing air in °C,
G = mass velocity as defined in equation 1.

Also $Q = F \times \Delta T \times$ Sp. Ht. . (11)

Where:

Q = heat transferred as defined in equation 10,

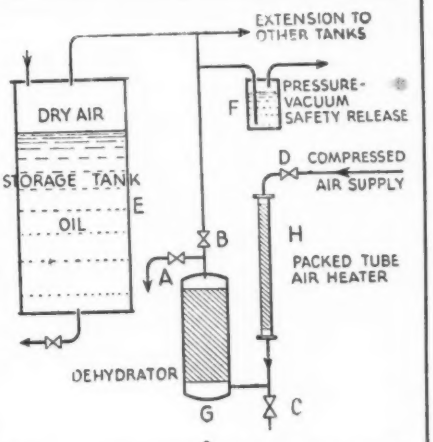

FIG. 4. Application of heater to tank breather dehydration system.

F = flow of air as defined in equation 8.
ΔT = rise in temperature of air °C.

The specific heat of air under the most unfavorable condition—*i.e.*, demanding most heat to attain a certain temperature—is found to be 0·0204 (at 200°C). The variation of specific heat with pressure can be neglected since it is negligible at all but very high pressures. For simplification, and to generally err on the side of safety, the inlet temperature of the air is taken as 0° C.

Therefore $\Delta T = T - O = T°C$.

Allowing a factor of 40 per cent for air humidity and heat losses, equation 11 can now be written:

$Q = 0{\cdot}0286\ FT$ . . . . . (12)

Also $A = \pi DL = 0{\cdot}52L$ (for 2-in. diameter tube) . . . . . (13)

Substituting values of G, Q, and A from equations 6, 12, and 13 respectively, in equation 10, and simplifying, we get:

$T/\theta = 0{\cdot}42\ L/F^{0.17}$ . . . . (14)

Where:

T = air outlet temperature °C,
F = flow of air at NTP in cu ft per second,
θ = mean temperature difference between tube walls and flowing air °C,
L = length of packed tube in feet.

In order to allow quick solutions, a nomograph (Fig. 2) has been constructed from the two simplified equations 8 and 14 (see sheet 1).

● **Acknowledgment.** The writer is indebted to Manchester Oil Refinery Ltd., at whose installation he developed this system, which was subsequently used as the basis of design for small heaters and which has proved entirely satisfactory.

Taken from P. H. Moore's article in *Petroleum*, January, 1946, published by Leonard Hill, Ltd., London.

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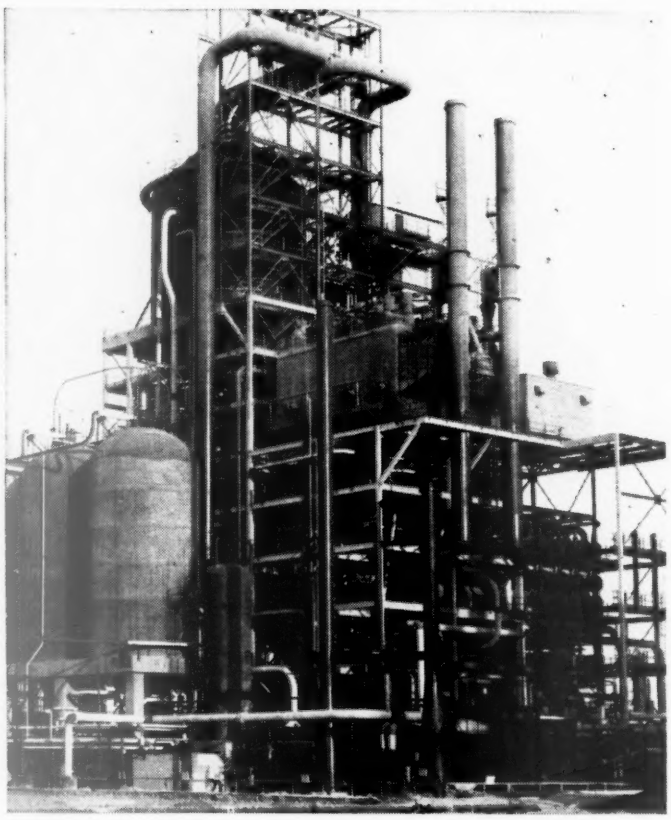

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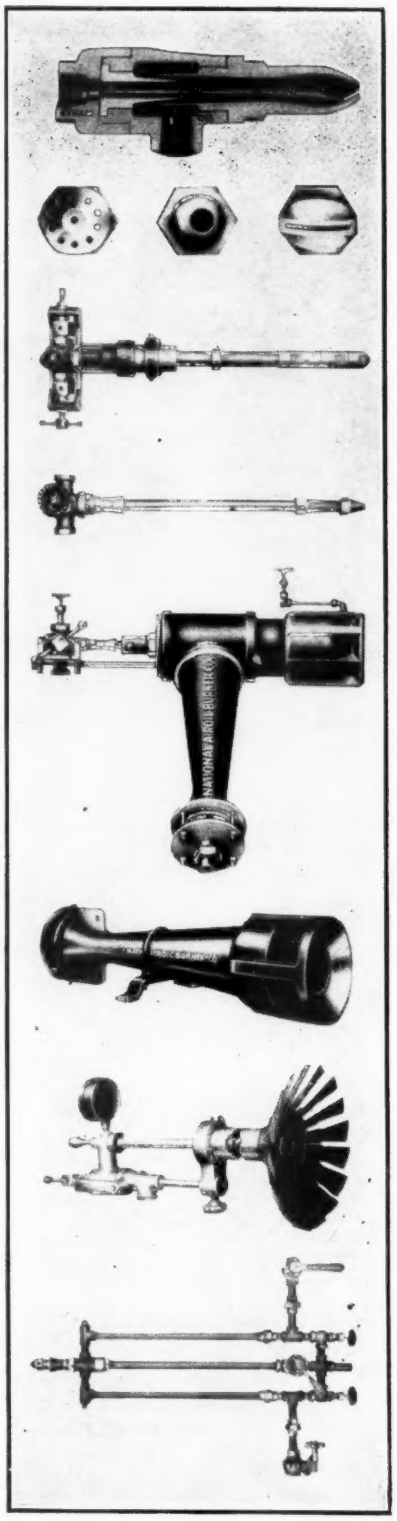
(Refuse Oil Burner) burns acids or caustic oils, sludges, asphalts, tank bottoms, polymer oils, heavy petrolatum, organic oil residuums, waste cutting oils, sulphite pulp liquors, etc.



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Aviation gasoline alkylation plant.

Safety and the chemical engineer

By CHARLES F. MONTROSS, The Lummus Company

With the rapid advance of safety-consciousness that has been taking place in the last decade, it has become more important than ever that highly skilled, technically trained men become conscious of its impact on their specialization.

Because of the pressure of their curriculum and the nature of their scholastic training, it is only when the chemical engineer enters industry after finishing college that he begins to realize the position and necessity of safety as it affects his everyday thought and activities.

The alert engineer will soon realize that safety is as much his problem as it is that of the worker in the plant, the foreman's, or the safety director's. Given the proper guidance and stimulus he will coordinate his engineering thinking with safety. Here the maximum cooperation between the personnel responsible for safety and the chemical engineer is mutually beneficial and gives overall benefits to the plant employing them.

The scope of the chemical engineer's activity may roughly be divided into three groups.

1. Research and development.
2. Design.
3. Operation.

In each of these phases his contribution may be considerable.

His expert knowledge of the chemical and physical processes as well as the equipment involved may be used to supplement the knowledge of the safety man in the protection again various hazards.

Laboratory equipment must be designed and properly housed to minimize the explosive and fire hazards inherent in their use. His knowledge of the characteristics of both the initial and final products is a valuable tool that can be used for the benefit of all concerned. He can also help in the proper layout of the laboratory and pilot plant facilities. To do this requires careful analysis of what is to be expected from the laboratory. When quantities of volatile and flammable materials are to be used they should be separated from other equipment using free flames or having high temperature heaters. Proper ventilation is not only important in the upper regions of the room, but sometimes in cases where the vapors are heavier than air, the lower regions are of equal importance. Proper materials of construction must be chosen. Operating the laboratory and pilot plant equipment presents problems that can be solved by an awareness and knowledge of safety. Here again the engineer with the proper background and in conjunction with the safety personnel involved can work out the least hazardous and most efficient methods.

It is particularly in the field of design that a chemical engineer can contribute broadly. The greatest activity on the part of safety personnel is the protection against hazards that exist because they are an integral part of the equipment and plant. Full consideration of these possible hazards at the time of the original design could incorporate into this design the proper measures and obviate the necessity of makeshift or temporary protection.

For example, consider the problems of dust nuisance. A particular process may be such that the gases that are vented to the air contain considerable fine materials. If the plant were situated far from any populated places and the dust itself were not harmful, it might be sufficient to design a stack of proper height so as to distribute the dust over a reasonable area. On the other hand, if the plant were in a populated area, assuming that the dust were not harmful, it would still be a nuisance and undesirable. Local ordinance might come into play and require special handling of this vented material. The design engineer must then answer the problem of "Just how clean must the gas be made in order to conform with the standards?" Perhaps it is sufficient to send the dust-gas mixture to a cyclone-type separator and get most of the fines out. Or perhaps it is necessary to send the gas to special scrubbing towers and dispose of the fines in the sewage systems or settling ponds. Consideration of this problem during the design of a plant may save a considerable sum of money and energy and, in the case where the dusts are hazardous, physical injuries and the concomitant medical and legal expenses.

Take another case. The chemical engineer has the problem of designing a vessel that will handle chemicals at fairly high pressures. The reactants are such that there is danger of a "wild" reaction taking place that will cause

abnormally high pressures and temperatures to be evolved.

Due consideration must be given to the type of protection. Certainly some relief mechanism must be provided. Should it be in the nature of a relief valve allowing a continuation of process, or is a rupture disk more desirable? What provisions must be made for leading off the generated vapors? In the petroleum industry the use of rupture disks alone is relatively unusual. A rupture disk may often be used in series with a relief valve where the service is highly corrosive, however. The rupture disk is placed next to the vessel to be protected. When it has burst, operation can be continued until an orderly shutdown can be made and the diaphragm replaced. This has the advantage of not requiring the relief valve to be constructed of highly non-corrosive and expensive materials.

Must the "wild" products be treated differently for disposal than the more usual ones? What pressure should a vessel be able to resist, of what materials should it be constructed to withstand both pressure and corrosion, and how should it be insulated to save heat and protect personnel?

Another series of problems of design are those dealing with emergency shutdowns and blow-downs as well as cleaning-out equipment. The design must incorporate the proper facilities situated in the most strategic positions. Snuffing steam should be available where it can be reached safely in any emergency. Remote control valves should be used generously where there is the possibility of an area being made inaccessible due to fire, heat, etc. Fire hazards should be isolated from heat sources.

When the chemical engineer has carefully considered all these problems he has made his design with safety in mind. The problems confronting the safety personnel during operations have been reduced, freeing them to apply their energies to other more pressing problems that were not or could not have been foreseen and prepared for beforehand.

These are direct contributions that the chemical engineer can and must take toward safety. There are indirect ones of equal importance. The very fact that the chemical engineer is aware of safety makes him look at a design problem differently. He will realize that there are certain facets of his problem that can best be solved by groups that have specialized in these branches. For instance, fire protection. Fire prevention is partly within his realm but his knowledge of fire fighting methods and equipment are perforce limited. He must look to the specialist in this field for many answers. Problems in pollution, industrial hygiene, materials of construction, and others of which he may have limited knowledge may also cause him to seek additional help. His awareness of safety makes him realize that these are real, live, and important problems. An engineer not cognizant of safety may not even realize that he has a problem.

Whereas the direct contact of design engineers and safety personnel is limited, it is in the operating and maintenance phase of chemical engineering that they can really complement each other. The proper methods of operation must be worked out by both and protection must be provided personnel and equipment. The men who are to be assigned to the equipment must receive proper and adequate instruction. Accident records must be kept, studied, and analyzed.

It is here too that personality clashes are most frequent and most damaging. The chemical engineer may, rightfully or wrongly, feel that safety personnel are transgressing onto his "territory." The safety engineer may resent the intrusion of the chemical engineer in what he considers his "domain." The line of distinction is often difficult to draw and it must of necessity be kept flexible. Only proper attitudes on the part of the individuals and groups involved can make for harmonious and beneficial cooperation.

The design and plant personnel can cooperate extensively in the location or re-location of equipment. Not only should the equipment be designed properly, it must be placed properly. Equipment made relatively difficult to get at tends to be neglected. Many a pump has not been serviced because it was out of the way, and many an instrument reading has been guessed at because it required too much effort to be reached.

After units have been designed they should be inspected regularly. A fault not apparent at the outset may become aggravated during operation. It should be caught and remedied as soon as practicable.

The petroleum industry has early shown an awareness of the problems of safety and has rightfully won a place as one of the leaders in this field. However proud it may be of its past achievements it must continue to remain alert to new improvements. From its raw materials to its final products, it deals with hazardous material. It handles them with potentially hazardous equipment. That, in spite of this, it has been able to retain its status as a leader in safety is all the more commendable and due to the safety-alertness of all the personnel and companies involved. ★ ★ ★

Azeotropic toluene plant.

Buy site for plant

Acquisition of a site by Stanolind Oil and Gas Company for the location of a chemical recovery and separation plant at Brownsville, Texas, has been announced by E. F. Bullard, president. The land adjoins the Carthage Hydrocol, Inc., synthesis gasoline plant now under construction. Stanolind will purchase all chemical by-products from the Carthage unit.

Firm incorporates

Hamel-Dahl Company, Providence, Rhode Island, has been incorporated, effective January 1. The incorporation will assure even more effective service to the petroleum and process industries as plant output will be increased with the addition of plant facilities, it is announced.

There will be no change in the management of the company. The following men comprise the officers and board of directors: E. T. Dahl, president; B. G. Woolley, treasurer; Bruce A. Irwin, vice president and secretary, and Thomas Ponton, vice president.

SCMA meets

At the January meeting of the Southern California Meter Association, Roy M. Bauer, gas supply supervisor of the Southern California Gas Company, presented a paper, "Weather-Gas Sendout Relationship," giving interesting and informative facts relating to the southern California fuel supply project. He discussed load demands, seasonal and daily variations, and the part played by the Texas-California gas line in supplying fuel to southern California.

In his paper, "The Function of Instruments in Weather Forecasting," Lieutenant C. R. Fean of the Los Angeles Alamitos Naval Air Base described the methods and equipment used by navy aerologists in predicting atmospheric conditions.

The meeting was held at the Rio Hondo Country Club January 15.

API meeting

The regular spring meeting of the Southwestern District, API Division of Production, will be held on April 14, 15, and 16, 1948, at the Plaza Hotel, San Antonio, Texas.

Al Buchanan, of Al Buchanan Drilling Company, San Antonio, Texas, has been appointed chairman of the general arrangements committee.

The program committee, under the chairmanship of R. E. Bridges of the Humble Oil and Refining Company, Houston, Texas, is already at work and has several good papers in prospect.

Root Petroleum sold

Purchase of a majority of the stock of the Root Petroleum Company by Pan American Petroleum Corporation is announced by D. P. Hamilton, president of Root, and Bruce K. Brown, president of Pan Am.

Root Petroleum Company's principal office is at Shreveport, Louisiana.

Hamilton participated in the organization of Root a quarter century ago and has for many years been its president and principal stockholder. He will continue as a director of the company.

The new president of Root will be Dwight F. Benton, who will resign his position as general manager of the lubricating and sales technical service departments of the Standard Oil Company (Indiana) to give full time service to Root. Horace Canon, who has been executive vice president and a director of Root, will continue to serve the company in his present capacity, as will the other officers and department heads.

ENGINEERS
Mechanical and Chemical

A major oil company actively engaged in construction of large synthesis plant, a number of natural gasoline and cycling plants, and other projects has several attractive openings for exprienced engineers. Prefer men with five years or more of successful engineering experience in refinery or gasoline plant design, operation, or construction. Positions are in Engineering and Construction Section, location Mid-Continent area. Salary and responsibility will be commensurate with experience and ability. Address Box 77, care of *The Petroleum Engineer*, P. O. Box 1589, Dallas, Texas.

1948 PETROLEUM DIRECTORY AVAILABLE

Barkley's Directory, the WHO'S WHERE among Producers, this year covers 18 States of Gulf, Mid-Cont. and Rky. Mt. areas. 400 pages of 30,000 listings include all producers and associated personnel. Send $15, under our MONEY-BACK guarantee, for your copy, or write for Sample Sheet E.

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EAST TEXAS FIELD MAPS, 1 in. = 2,000 ft. *Ownership maps, Gasoline plant maps,* showing location and lease connections; *Water maps in colors,* showing encroachment by stages, wells making water, abandoned area, and salt water injection wells. Write *Bob Kyner, Box 976, Ft. Worth, Tex.*

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Bethlehem promotions

Behlehem Supply Company announces the promotions of several of its personnel to field representatives. This policy is being carried on throughout the entire organization in order to give more efficient service to its customers, the announcement says.

T. W. Teague, formerly at the Winnsboro, Texas, store, was promoted to field representative at the Shreveport, Louisiana, store.

N. E. Formby, formerly at the Kilgore, Texas, store was promoted to field representative at the Winnsboro, Texas, store. Formby had three years' experience in the oil field supply business prior to his affiliation with Bethlehem in July, 1945.

B. K. Smith, formerly special representative in the used material department at Kilgore, Texas, has been transferred to the Corpus Christi, Texas, district office and store and promoted to field representative for general equipment sales. Smith has had more than ten years' experience in the oil industry, being employed by Stanolind Oil and Gas Company before joining Bethlehem in March, 1946.

E. M. Slette at the New Iberia, Louisiana, district office and store, H. L. Daniels at the Lake Charles, Louisiana, store and L. E. Garner, Jr., at the Hobbs, New Mexico, store have recently been promoted to field representatives and will operate from their present respective stores.

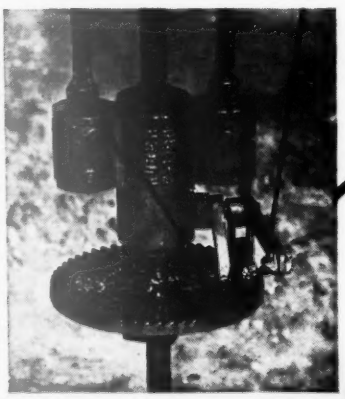
No More PARAFFIN ACCUMULATION

HUBER

Imagine what you could save by eliminating the frequent and costly job of steaming out or "passing rods" to free your well of paraffin.

Huber Scrapers make a paraffin scraper out of your sucker rod string. These steel blades, shrink-welded to the rods, scrape the paraffin from the tubing as the string rotates and reciprocates. With the string rotated a fraction of a turn on each stroke, the scrapers keep the tubing wall free of any paraffin.

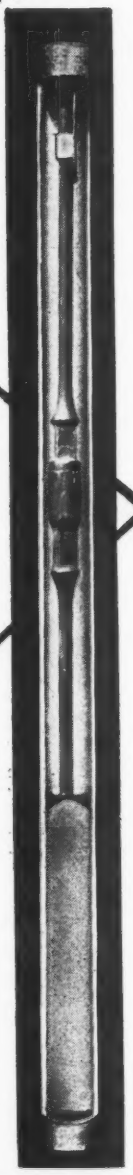
Operation of the Huber Scrapers is automatic and entirely mechanical. They require no service or attention. Install Huber Scrapers in your paraffin wells and eliminate the cost of paraffin removal.



AUTOMATIC ROD ROTATION

This rotating rod hanger is attached to the unit's or jack's head by conventional wire line bridle. Two ratchet levers engage the turntable, and by means of a flexible steel cable from the ratchet arm to the walking beam, the rods are rotated a fraction of a turn with every stroke of the pump.

ORDER FROM YOUR SUPPLY STORE



HUBER

J. M. HUBER CORPORATION

BOX 831 BORGER, TEXAS

Technical director

Howard E. Degler has been appointed technical director of The Marley Company, Inc., Kansas City, Kansas, manufacturers of water cooling towers and other water cooling equipment. He will assume his new duties February 1.

Howard E. Degler

Degler has been professor of mechanical engineering at the University of Texas since 1930 except for one year spent in England with the Army Information and Education Service. He headed the department for 15 years.

He also taught for eight years at the University of Illinois and prior to that time was a design engineer for oil and power companies. He received his mechanical engineering degree from Lehigh University in 1914 and his master's degree from the University of Illinois in 1927.

Heads drilling firm

The board of directors of Loffland Brothers Company, oil well drilling contractors of Tulsa, Oklahoma, announces the election of R. W. (Bob) Wire of Dallas, Texas, as the company's new president and general manager, effective January 1.

R. W. (Bob) Wire

Prior to his election, Wire was sales manager of the southwestern area for the National Tube Company, which includes the Tulsa, Dallas, Houston, Denver, and New Orleans districts, maintaining headquarters in Dallas. Wire is widely known in the oil country and has been a prominent figure in the petroleum equipment supplies industry.

He is a native of Lorain, Ohio, and a graduate of Miami University of Ohio. He was with the National Tube Company for more than 25 years, first as field engineer, sales manager of the Chicago area, assistant general sales manager, and in 1945 he moved to the Mid-Continent territory in the position he has just resigned.

Coast AAPG

The Pacific Coast section of the American Association of Petroleum Geologists held its first luncheon meeting of the new year on January 8 at the Clark Hotel, Los Angeles. Earl B. Noble, manager of exploration for the Union Oil Company, spoke on "Oil Exploration in Northern Alaska." Noble recently returned from a trip to Alaska.

Named manager

W. R. Ryburn has been appointed manager of drilling equipment sales of Oil Field Machinery and Equipment Division, National Supply Company, according to an announcement made by R. W. Gordon, manager, oil field sales. Ryburn will make his headquarters in Toledo, Ohio. He joined the company in 1928 and served in the capacities of store man in National Supply's Shelby and Conrad, Montana, stores and as field salesman in its Casper and Cody, Wyoming, stores. In 1938, he was transferred to the general sales department at Toledo.

W. R. Ryburn

Upon leaving the University of Michigan, Ryburn was employed in the land and lease department of The California Company in Montana and worked for various drilling contractors in Montana and Wyoming from 1924 to 1928.

Brown expands

The Brown Instrument Company has expanded its sales and service activities in the Rocky Mountain area by establishing permanent sales and service representation at 400 Broadway, Denver, Colorado, and 437 Atlas Building, 36½ West Second South, Salt Lake City, Utah, it was announced by William H. Steinkamp, field sales manager of the industrial division of Minneapolis-Honeywell Regulator Company.

Donald Larcen has been placed in charge of Denver industrial sales and George Winslow, formerly industrial service manager at Detroit, will handle similar duties in Salt Lake City, where he will work with Eldon Richardson, district manager.

The areas to be covered by the Denver branch, said Steinkamp, will include all Colorado, Wyoming, and western Nebraska. The Salt Lake City district will cover all of Utah, southern Idaho, and western Nevada.

Christmas checks

For the second consecutive year Christmas checks double the amount given in previous years were presented to all salaried employes of Larkin Packer Company, Inc., W. H. Larkin, president, announced. The checks were given as an expression of appreciation for their continued loyalty, Larkin said.

Prior to the present plan of doubling Christmas checks, Larkin employes received from 3 to 12 per cent of their annual wage, depending on length of service. Amounts this year varied from 6 to 24 per cent.

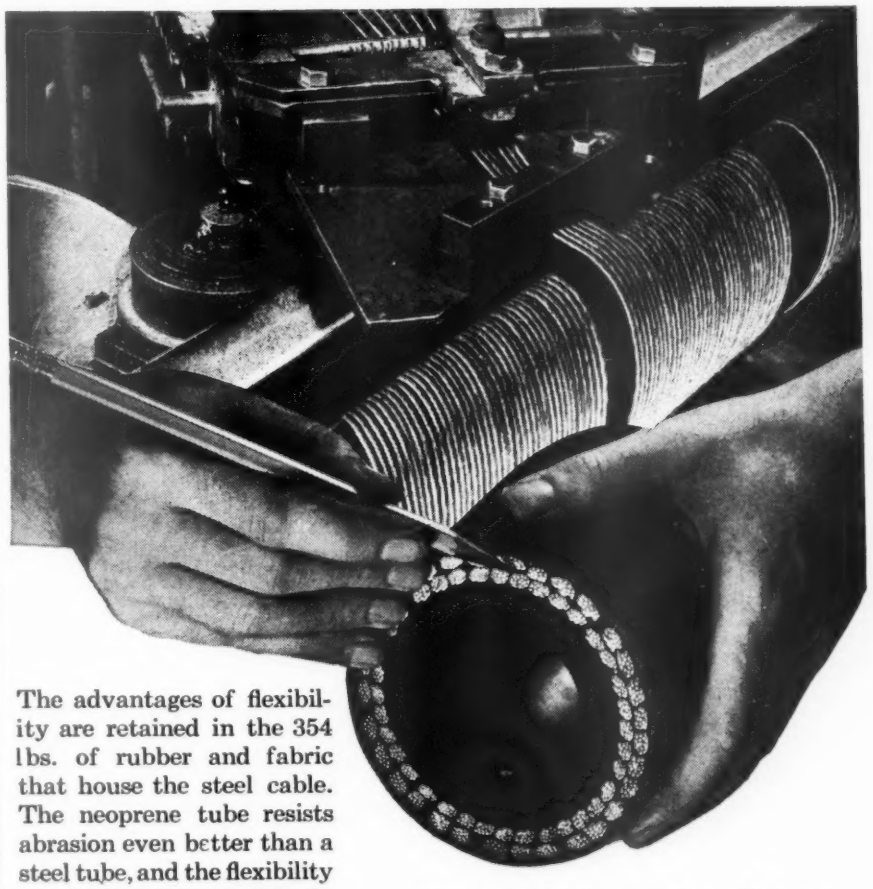
The main office and manufacturing plant of Larkin Packer Company, Inc., manufacturers of oil well cementing and production equipment, is in St. Louis, Missouri.

This "Rubber" Hose

is 67% steel!

716 lbs. of steel for strength—354 lbs. o frubber and fabric for flexibility—that's the efficient make up of Thermoid Powerflex Rotary Hose, built to go "all the way" in deep hole drilling!

Thirty-three *miles* of high tensile steel wire, formed into 9300 ft. of cable, and precision wrapped—and counter-wrapped, gives each length of Thermoid Powerflex Rotary Hose strength to withstand the highest pressures that may develop under any condition.



The advantages of flexibility are retained in the 354 lbs. of rubber and fabric that house the steel cable. The neoprene tube resists abrasion even better than a steel tube, and the flexibility needed for rotary work is obtained in a single, unbroken, free-flowing length of hose.

Thermoid Powerflex Rotary Hose has the strength *of steel—and the* flexibility *of rubber!*

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Matched Equipment — Matchless Service

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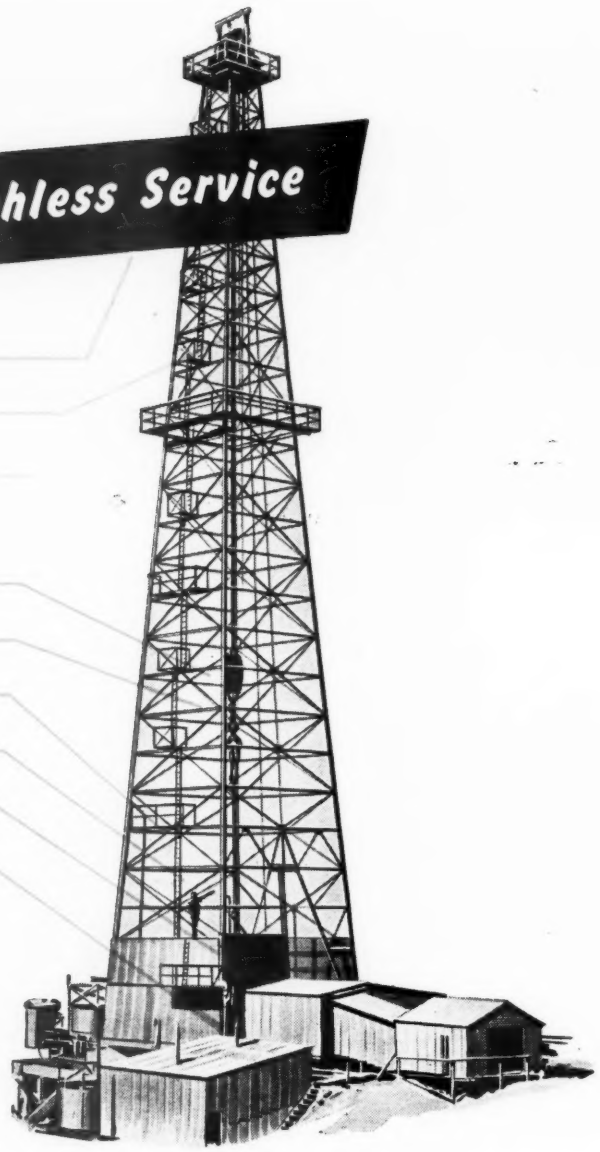
- CLARK-IDECO drawworks
- CLARK-IDECO slush pumps
- IDECO substructures
- IDECO rotary tables
- IDECO cable tool rigs
- SECURITY bits and reamers
- IDECO drilling and fishing tools
- IDECO spudders
- SECURITY drillable casing



You always have a problem while drilling a well, haven't you?

Suppose, just for example, you want to load a bit with collars. That extra weight affects all the equipment above the bit. The problem should be handled as an over-all job. If you deal with Dresser Industries, you deal with the one outfit that knows the effects of your problem from the tip of the derrick to the bottom of the hole.

The member companies of Dresser Industries pass their information back and forth. A development in bits at *Security* is known to the engineers of derricks at *Ideco*. And vice versa. All pieces of equipment are kept in balance.

Dresser Industries' knowledge of the over-all engineering forewarns you of trouble from unbalanced combinations of equipment.

The policy of Dresser Industries is not to compromise engineering for a sale. This carries through from well to refinery. Dresser-owned companies build equipment according to a variety of principles all along the line. You buy the type you need for best results—not some solo piece for which a salesman is holding the torch.

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KOBE, Inc.
Huntington Park, Calif.

PACIFIC Pumps, Inc.
Huntington Park, Calif.

PAYNE Furnace Co.
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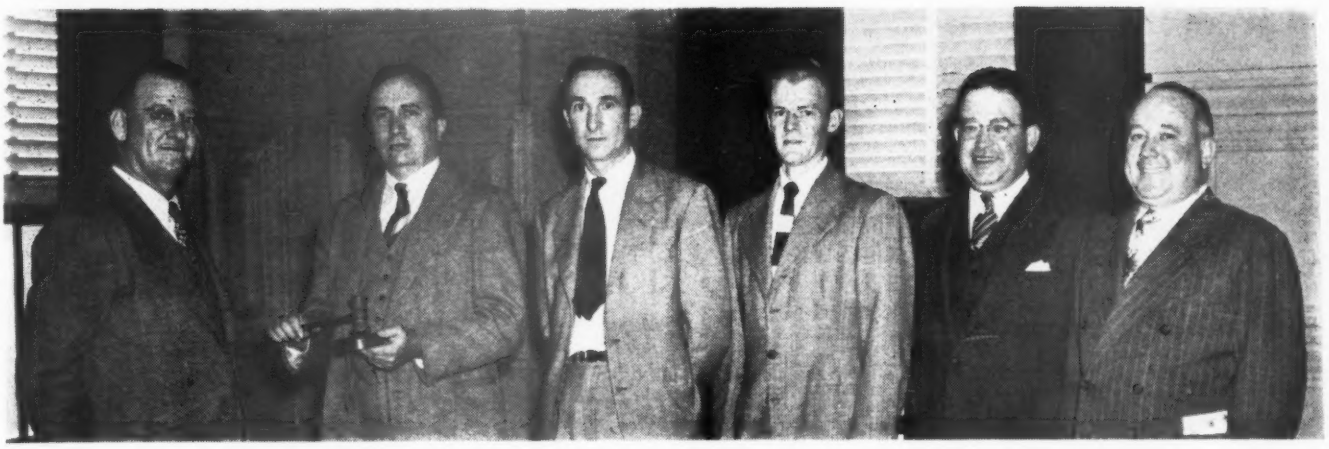
ROOTS-CONNERSVILLE Blower Corp.
Connersville, Ind.

SECURITY Engineering Co., Inc.
Whittier, Calif.

STACEY BROS. Gas Construction Company
Cincinnati, Ohio

Stacey-Dresser Engineering Division
Cleveland, Ohio

New officers of Dallas Petroleum Engineers' Club



Dewey A. Jordan (left), retiring president, presents the gavel of the Petroleum Engineers' Club of Dallas to the new officers for 1948: (left to right) K. Marshall Fagin, president; Henry J. Gruy, vice president of programs; John R. Coombs, vice president of arrangements; Charles D. Deschner, vice president of membership, and Ralph U. Maddox, secretary-treasurer. Jordan is operating superintendent of production for Atlantic Refining Company; Fagin is field editor for The Petroleum Engineer; Gruy is a petroleum engineer for De-Golyer and MacNaughton; Coombs is a petroleum engineer for Magnolia Petroleum Company; Deschner is with Continental Supply Company; and Maddox is with Big West Drilling Company.

President Le Roi

Le Roi Company announces that C. W. Pendock has resigned as its president. E. A. Longenecker, who has been president of the Lauson Division of Hart-Carter Company, was suggested by Pendock and was elected as his successor by

E. A. Longenecker

C. W. Pendock

the board of directors. Pendock was elected to the position of chairman of the board.

Pendock has been the only president in the company's history. He sparked its growth from a small machine tool shop in 1914 to one of the industry's leading manufacturers.

The company states that a great many of its products today were either designed or developed by Pendock.

Longenecker, the new president, is already familiar with the manufacture of Le Roi products (engines, compressors, rock drills, generator sets, and highway mowers) having been in a closely allied industry and also an instructor in engine design at the University of Wisconsin.

Bethlehem promotes

Bethlehem Supply Company announces several promotions in its personnel.

W. A. "Babe" LaRew, formerly special representative at Odessa, Texas, has been promoted to assistant manager of the West Texas-New Mexico district with headquarters at Odessa, Texas.

E. R. Phillips has been appointed special representative on sales and service for the entire Illinois District.

T. H. Anderson, formerly pump shop operator and floorman at Sundown, Texas, has been advanced to field representative at Sundown, Texas.

Name change

As a compliment to the men in the field a change in name from "Perf-Test" to "Shoot-N-Test" has been announced by M. O. Johnson Oil Field Service Corporation for its mechanically-operated, hydrostatically-fired gun perforator. The term "Shoot-N-Test" has been adopted because it so well describes the function of the Johnston All-Purpose Gun Perforator as the perforating unit in combined perforating and testing operations and the flexibility afforded in running in on tubing or drill pipe. The change in name has been made to better identify the tool to oil men who have consistently called for "Shooting Tests."

Sales conference

About 175 people attended the annual sales conference of the Industrial Truck Division of the Hyster Company in Danville, Illinois, January 8, 9 and 10. Attending were export and domestic dealers as well as Hyster Company personnel. Among the export group were Wellington Koo, Jr., of the Tien Yuen Industrial Corporation, China; J. A. Bon of Geveke and Company, Netherlands, and I. R. Benoliel and Cia., Brazil.

Sessions including equipment displays and talks by E. G. Swigert, president; Eugene Caldwell, general manager, and other company and distributor personnel were held in the Wolford Hotel in Danville. A trip through the Danville plant of the company was made under the direction of Dan Sheehan, who is local manager for the Hyster Company, which also has plants in Portland, Oregon, and Peoria, Illinois.

Following the conference, participants left on a special train for the National Materials Handling show in Cleveland.

To new plant

Peerless Manufacturing Company, Dallas, Texas, manufacturers of specialty equipment for the gas, oil, and chemical industries, has moved into its new plant, according to E. O. Haltom, new Peerless sales manager. The plant, spread over 20 acres just north of Dallas, has more than 15,000 sq ft of factory and office space and is designed to increase the plant's output manyfold.

E. O. Haltom

Haltom, who has recently taken his post as manager of sales, is well known throughout the oil and chemical industries. He joined Peerless after 20 years' service in the production and the sales departments of Wyatt Metal and Boiler Works at Dallas.

Other officers of the newly expanded company are Mrs. D. A. Sillers, president, replacing her husband, the late Don A. Sillers; J. A. Mundie, former assistant manager of the Chase Bag Company's Dallas plant, vice president; Raymond B. Owens, nationally known petroleum and chemical engineer, vice president and chief engineer, and Mrs. Mary H. White, veteran Peerless employe, secretary and treasurer.

Announces meeting

The Texas Mid-Continent Oil and Gas Association's 29th annual meeting will be held at Fort Worth October 14 and 15, 1948, Charles E. Simons, vice president and general manager, has announced.

Fort Worth was selected for the next meeting of Texas oil and gas operators during the San Antonio convention this year but the exact date was not set at that time. The last Fort Worth meeting for the full membership was held in 1943.

running tour with men in the industry

● **Charles B. Dale** of New York City has joined the production research department of the Pennsylvania Grade Crude Oil Association as a chemical engineer in the association's laboratory at Bradford, Pennsylvania. Dale has been a chemical engineer on the staff of Foster Wheeler Corporation of New York City, designers and builders of petroleum refinery equipment. Prior to joining Foster Wheeler's staff, he was a research engineer with Shell Development Company, Wilmington, California.

● **Harry W. Denton,** Midland, Texas, has been named West Texas-New Mexico sales representative for McKissick Products Corporation, Tulsa, Oklahoma. He succeeds **Tom H. Gutelius,** recently deceased.

● **M. W. Reed,** vice president-engineering for Carnegie-Illinois Steel Corporation, has been appointed chief engineer, United States Steel Corporation of Delaware. Reed has served with U. S. Steel subsidiaries continuously since 1916, joining American Steel and Wire Company after his graduation that year from the U. S. Naval Academy with a bachelor of science degree. He rose to become vice president of that company in 1937, serving in that capacity until his appointment as chief engineer of Carnegie-Illinois in 1939. He has been in his present position since April, 1947.

● **Dr. E. F. Davis,** vice president of Shell Oil Company, Inc., and the company's chief consulting geologist for the North American continent, retired January 1 after nearly 30 years' service. Dr. Davis' long career covered a period of achievement and growth. Shell's holdings in many California oil fields were obtained during this time. One of these producing areas was Ten Section field in Kern County, the first California oil field to be located entirely by seismic methods. Many other advances were made in petroleum technology, enabling men to drill deeper and recover larger proportions of oil.

Dr. E. F. Davis

Dr. Davis attended the University of California where he obtained his Ph.D. in 1917. Shortly thereafter he joined Shell in New Mexico and moved to California in 1922 as chief geologist, a position he held until 1929 when he was elevated to vice president and chief geologist. In 1940 he succeeded the late J. U. Stair as vice president in charge of the Los Angeles office. Dr. Davis continued in this capacity until December 1, 1944, when in addition to his vice presidential duties he became chief consulting geologist for the North American continent.

● **F. W. Littell,** superintendent of communications and transport facilities of Shell Pipe Line Corporation, has been named chairman, Central Committee of Radio Facilities, Division of Transportation, in the American Petroleum Institute. Native of Kentucky, Littell attended Washington University in St. Louis and began his 28-year career with Shell in 1919 as a telegraph operator. He was made chief clerk in St. Louis in 1930, and later assistant to the general superintendent of telephone and telegraph. In May, 1940, he was transferred to Houston as division superintendent of telephone and telegraph, and in 1942 was elevated to his present position.

F. W. Littell

● **Ralph S. Orme,** for 10 years employed by the Federal Power Commission as gas engineer on rate cases and more recently engineer on gas certificate dockets, has resigned to enter the pipe line construction business in Texas. The FPC gas division and commissioners joined in a "going away party" for Orme. Dan C. Hayne, as master of ceremonies on behalf of commissioners and associates, presented Orme with a leather cowhide brief case and a gold Waltham wrist watch with expansion bracelet.

● **Tommy Johnston,** general manager of the M. O. Johnston Oil Field Service Corporation, Los Angeles, California, recently made a six weeks' field inspection and sales trip via the company's airplane to Oklahoma, Texas, West Texas, and New Mexico. Considerable time was spent in the Permian Basin and a new service branch was established at Cisco, Texas, to keep pace with the increased demand for Johnston formation testing and "Shoot-N-Test" gun perforating equipment.

Tommy Johnston

● **Earl L. McNeill** has been appointed drilling superintendent of the Coast Company at Houston. McNeill previously was with Skelly Oil Company and the Allied Well Service, Inc. of Houston and joined the Coast Company from Crown Central Petroleum Company, where he was drilling and production superintendent. He is a native Houstonian, a graduate of Sam Houston High School, attended Rice Institute, and is president of the Houston Technical Club.

● **Bay E. Estes, Jr.,** has been appointed director of commercial research, United States Steel Corporation of Delaware. He succeeds **Kemp G. Fuller,** who has resigned. Estes joined the commercial research division of the Delaware Corporation in 1939.

● **Earl A. Nichols** announced recently that he is entering business for himself as a consulting petroleum engineer with offices in the Professional Building, 2000 Kidwell, Dallas, Texas. He will specialize on material balance calculations, waterflood engineering studies, and appraisal and evaluation of producing properties. Nichols graduated from Texas Christian University in 1937 and did some post-graduate work at Washington University, St. Louis. He was formerly the manager of the Mid-Continent Division for Core Laboratories. Prior to his services with Core Laboratories, he worked for Carter Oil Company and Phillips Petroleum Company in Oklahoma.

Earl A. Nichols

● **L. G. Smith,** vice president in charge of refining activities, was elected a member of the board of directors of the Creole Petroleum Corporation. At the same time the company announced the resignations from the board of directors of **W. J. Haley** and **W. R. Goodwin.**

● **Don O. Chapell,** division geologist for Sunray Oil Corporation, San Antonio, Texas, has been named a vice president of the company, and will direct a new department of exploration, according to an announcement by **C. H. Wright,** Sunray president.

The appointment of Chapell to this new position in the Sunray organization, effective January 1, is the company's first step in a new program of activity and expansion that Sunray plans in the Mid-Continent states and California. Chapell will move to Tulsa and will set up his new office here. **H. S. McClintock,** vice president, will continue to direct Sunray's land department.

● **T. A. Atkinson,** for the past three years assistant superintendent of the southern division of General Petroleum Corporation's production department, has been named assistant manager of the company's industrial relations department. Atkinson, the son of an oil man, began his career with G. P. by working summers from 1926 to 1931. He joined the company in 1935 as a well puller and has occupied various positions in the production department. He received his B.S. degree at the University of California at Berkeley.

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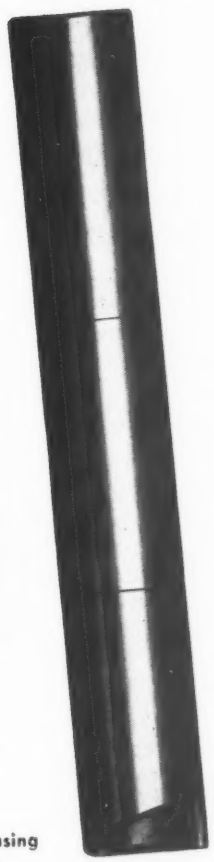

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Rotary
Releasing
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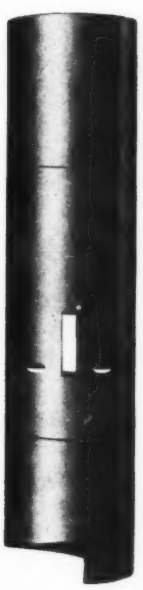

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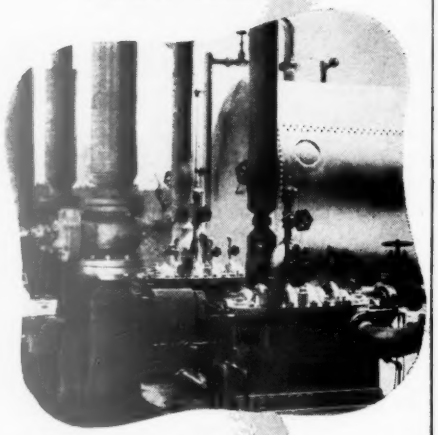

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● **Dr. Wallace Reed Brode,** internationally known chemist, has been appointed associate director of the National Bureau of Standards, acording to an announcement by **Dr. E. U. Condon,** director of the bureau. He succeeds **Dr. Hugh L. Dryden,** who was recently appointed director of aeronautical research of the National Advisory Committee for Aeronautics. Dr. Brode has done outstanding work in spectroscopy. He comes to the Bureau from Ohio State University, where he has been professor of chemistry. At the Bureau of Standards he will act as liaison between the Bureau and the Department of National Defense. He will also coordinate bureau research done for other federal departments.

● **W. L. Ducker,** who has held responsible positions in many phases of the petroleum industry for the last 15 years, has been named professor of petroleum engineering at Texas Technological College, Lubbock, Texas, and will serve as head of the department for the remainder of the 1947-48 year.

Ducker's appointment is among the first steps taken by the college in launching a major expansion program in the field of engineering as related to petroleum and other basic minerals, Dr. W. M. Whyburn, president, stated.

College officials have been holding periodic conferences with industrial leaders for more than a year in an effort to outline curricula best suited to industrial needs. Ducker will spend several months assembling equipment and staff needed to fully service these curricula.

Ducker is a graduate of the University of Oklahoma where he specialized in petroleum and mechanical engineering. Among the positions he has held are district engineer for Barnsdall Oil Company, chief engineer for Seismograph Service Corporation, chief engineer and general manager, Engineering Laboratories, Inc., chief engineer for Bovaird Supply Company, and acting manager for Oklahoma, War Production Board, June, 1941, to April, 1942. Since the latter date he has been in private consultation practice in Tulsa.

● **W. C. (Bill) Stout** has been named assistant manager of Continental Oil Company's land department in charge of the southern region, with headquarters in Houston. He succeeded **A. K. (Knox) Tyson,** who has resigned to become associated with the Barber Asphalt Company. Stout was division land superintendent for Continental at Fort Worth prior to the present appointment and has been in the oil business for nearly 30 years.

● **Jim L. Huitt** has recently been appointed to the Aluminum Company of America Fellowship in the School of Chemical Engineering at the University of Oklahoma. Huitt is a graduate of Louisiana Polytechnic Institute. During the war he served as an infantry lieutenant in the European Theater. He is now a graduate assistant in the School of Chemical Engineering and is working toward a master's degree. His research pertains to a study of "The Catalytic Dehydrogenation of n-Butane."

● **E. D. Smith** has retired as director and vice president and manager of production for Magnolia Petroleum Company, and **A. E. Chester** has been named as his successor, it was announced by **J. L. Latimer,** president of the company. These changes became effective January 1.

E. D. Smith

Smith first entered the oil industry as a roustabout with the South Penn Oil Company at the age of 16. He was employed by Magnolia on October 18, 1918, as production foreman at Augusta, Kansas. In successive steps he was promoted to district superintendent, division superintendent, and general superintendent. In January, 1944, he was elected to the board of directors and named vice president and manager of production. After 29 years

A. E. Chester

R. D. Hanley

of service Smith is being retired under the company's annuity and insurance plan.

Chester was employed by the Magnolia Petroleum Company on August 22, 1919, in the Old Desdemona district in the clean-out tools division. After service in several oil fields, he was promoted in 1926 to foreman and in 1935 to district superintendent. He was transferred to the general office in Dallas in January, 1944, to serve as assistant manager of production.

Latimer also announced that **R. D. Hanley** was elected a member of the board of directors of the Magnolia Petroleum Company effective January 1. Hanley began working for the Magnolia Gas Company in June, 1925. He was transferred to the Magnolia Petroleum Company in 1930 as chief chemist of the natural gas department. In 1938 he was made general superintendent of that department and in 1942 was named manager of the natural gas department.

M. V. C. Bradley succeeds Chester as assistant manager of production. Bradley has been an employe of the company for more than 26 years, and has been general superintendent of production since August, 1946.

● **Eddie Trapp,** formerly associated with Halliburton Oil Well Cementing Company in the field and the sales division, has joined Agency Associates, Inc., Los Angeles, as an account executive.

● **A. L. Solliday** has been elected executive vice president of Stanolind Oil and Gas Company, and **J. E. Rouse** has been named to succeed Solliday as operating vice president.

Solliday, a native of Watertown, Wisconsin, was employed as a scout by the Dixie Oil Company after receiving his degree in geology from the University of Oklahoma in 1923. In 1925 he became district geologist, and when Stanolind was organized January 1, 1931, he was promoted to superintendent of the land

A. L. Solliday

J. E. Rouse

department. In 1932 he became manager of the exploration department and held this position until 1944 when he was elected a director and vice president in charge of operations.

Rouse received a degree in mechanical engineering from Brown University in 1913, and immediately went to work for the Standard Oil Company of New Jersey at the Bayonne, New Jersey, refinery. In 1918 he joined the Midwest Refining Company as a construction engineer, and when the Midwest was purchased by Standard Oil Company (Indiana) in 1921 he was promoted to assistant general superintendent of the Casper refinery. Ten years later he was placed in charge of all refineries in the Rocky Mountain division. Rouse became assistant general manager of manufacturing for Standard Oil Company (Indiana) in 1933 and held this position until July, 1943, when he was loaned to the Government, first for work with the Petroleum Administration for War and later with the Navy Department. He joined Stanolind Oil and Gas Company in November, 1945, as manager of the manufacturing department, and on January 1, 1947, was elected director in charge of manufacturing and producing operations.

● **A. W. Walker** recently severed his connection with Stanolind Oil and Gas Company to become an associate professor at Tulsa University, working directly under Professor Sidwell of the Petroleum Production Engineering Department with special emphasis on reservoir engineering. Walker is a graduate of the Missouri School of Mines. His first experience in the oil fields was in Venezuela in 1925 and 1926. Later he worked for several years in the Seminole and Oklahoma City fields for different companies, principally I.T.I.O. In 1931 he joined the staff of Stanolind Oil and Gas Company. For the last several years he has been assistant to the consulting and research engineer.

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● **R. O. Swayze,** manager of General Petroleum Corporation's California production operations, has announced these promotions:

J. J. Oliphant becomes production superintendent of the San Joaquin Division with headquarters at Taft; **C. C. Gandaubert** was named assistant superintendent for the Southern Division with offices at Vernon, and **A. L. Hair** was appointed drilling superintendent for the same division, stationed at the concern's Wilmington production office. Oliphant, lately assistant to the division superintendent at Taft, was first employed by G. P. in 1929 as a clerk in the production department at Vernon. Gandaubert, recently drilling foreman in the Southern Division, first worked for the company as a roustabout at Ventura in 1920 and progressed through the ranks to drilling foreman at Santa Fe Springs in 1928. Hair's first job with the company in 1920 was that of rotary helper and, like Gandaubert, he became a drilling foreman in 1928 at Santa Fe Springs. At the time of his new appointment, he was drilling foreman in the Coastal Division at Ventura.

● **John C. Sample,** former general sales manager, has been made a vice president of General Petroleum Corporation, as has **Arthur J. Donnelly,** industrial relations manager. **Gale L. Adams,** manager of the manufacturing department, was named a vice president and director, and **Carroll M. Wagner,** manager of the geological department, likewise was chosen a director.

● **C. G. Herrington,** Mattoon, Illinois, has been made assistant manager of the production department of Carter Oil Company in the Tulsa headquarters office. **K. A. Ackley,** Mattoon, was named division manager for the Eastern division and also will continue to direct exploration activities in the division, which is composed of Carter operations in Illinois, Michigan, Indiana, Kentucky, and Tennessee. **O. D. Harper,** Mattoon, was appointed production superintendent of the division and will have charge of producing operations in the five-state area.

● **Clarence S. Beesemyer** and **Philip S. Magruder** have been elected executive vice presidents of the General Petro-

C. S. Bessemeyer

P. S. Magruder

leum Corporation, Los Angeles. Both men have been vice presidents and directors of General Petroleum, with Beesemyer serving as director of marketing and Magruder as manager of the manufacturing department.

● **Stanley J. Roush,** executive vice president of Kerotest Manufacturing Company, announces the appointment of **E. T. "Kink" Adams** as director of purchases of Kerotest Manufacturing Company. Adams has been foreign representative for Kerotest and for 12 years had been purchasing agent of the Sinclair Oil Company in Mexico. Prior to that time, he had been in the material department of the Standard Oil Company of Venezuela.

● **R. Conrad Cooper** has been made vice president, industrial engineering, of United States Steel Corporation of Delaware.

Cooper assumed this newly created position on January 1. During World War II he served as industry member of the National War Labor Board Steel Commission, and with the War Manpower Commission as management member of the management-labor policy committee. He is a member and past chairman of the industrial relations committee of the American Iron and Steel Institute.

● **Thomas V. Koykka** has been appointed to the board of directors of The Lincoln Electric Company to serve until the next annual election, according to an announcement by **J. F. Lincoln.** Koykka is a partner in the law firm of McKeehan, Merrick, Arter & Stewart and Geo. Wm. Cottrell. He has been associated with the law firm since his graduation from the University of Michigan Law School in 1930. He will serve on the board to fill the unexpired term of his partner, the late W. B. Stewart.

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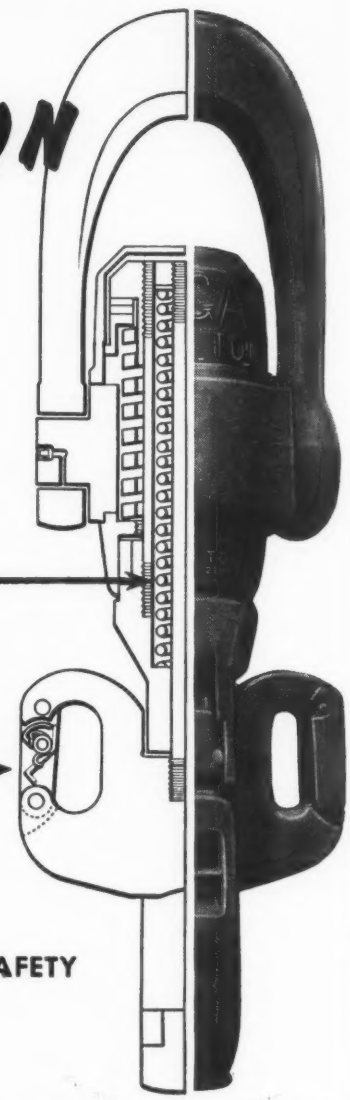

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● **P. T. Amstutz, Jr.,** and **G. L. Yates** have announced the formation of Amstutz and Yates, Inc., with offices at 406 K F H Building, Wichita, Kansas. Amstutz formerly was head reservoir engineer for the Standard Oil Company (Ohio), and Yates was head valuation engineer for the same company. The new firm will act as consulting reservoir and valuation engineers.

● **Roman F. Arnoldy** has been elected president and general manager of Houston Heat Treating Company, Inc. Arnoldy formerly was a development engineer with Union Carbide and Carbon Research Laboratories and has been active in research and development of flame hardening since 1936. A graduate of the University of Minnesota in 1933 with a degree in metallurgical engineering, he is a recognized authority on flame hardening.

● **Robert W. Miller,** widely known California industrialist, has been elected to the board of directors of the Standard Oil Company of California. Miller is president of Pacific Lighting Corporation, director of the American Trust Company, The Paraffine Companies, Inc., Tucker Investment Company, and Pacific Public Service. He has been an officer of Pacific Lighting since 1924 and was elected president in 1940.

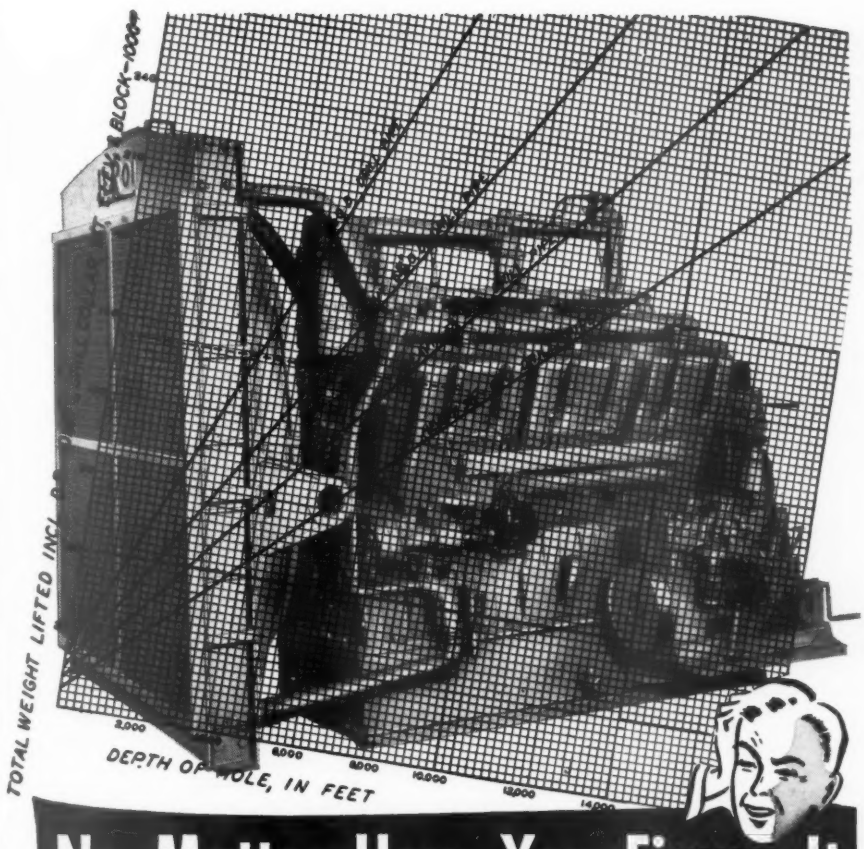
● **Chad J. Steward** has been named advertising manager of Dowell Incorporated. Steward, a graduate of the University of Tulsa, has had several years' experience in advertising and public relations, and has been associated with Dowell sales and advertisement departments since 1941 except for the war.

● **H. Vinton Potter** has been appointed coordinator of promotion of the American Gas Association effective January 1. Potter, who formerly served as director of the association's new freedom gas kitchen program, will coordinate all promotional activities of the associations on an industry-wide basis under the new organizational procedure instituted with the adoption of the promotion, advertising and research plan by the executive board of AGA.

● **James T. Wood, Jr.,** manager of The Texas Company's producing operations in California has announced promotions in the production department as follows:

In the engineering division, **T. W. Bell** changes from district engineer Fellows district to division engineer with headquarters in Los Angeles. **W. F. Cory** from development engineer Los Angeles Basin district to district engineer Fellows district. **L. E. Chatfield** from production engineer Fellows district to district engineer Sacramento district. **O. W. Chonette** from production engineer Los Angeles Basin district to district engineer Los Angeles Basin district, and **F. W. Maloney** from production engineer to district engineer Ventura district.

In the production and drilling division, **R. L. Patton** changes from district engineer Ventura district to assistant superintendent Ventura district.



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Kansas
Carson Machine and Supply Co.—Great Bend

Illinois — Western Kentucky
Western Machinery Company — Centralia, Illinois and St. Louis, Missouri.

Michigan
Hafer Engine Co. — Reed City

Rocky Mountain Area
Industrial Power Units, Inc. — Casper, Wyoming.

Northern Louisiana & Mississippi
Ingersoll Corporation — Shreveport, Louisiana, and Jackson, Mississippi.

West Coast
Le Roi-Rix Machinery Co. — Los Angeles, Calif.

Appalachian Area
Lloyd, Smith Company — Bradford, Penn.
P. C. McKenzie Co. — Pittsburgh

Canada
Drilling Supplies, Ltd. — Calgary, Alberta

Complete Sales and Service Facilities

P-92

Joe: What are the names of the bones in your hand?

Jim: Dice.

* * *

First Window Washer: Look at that guy in there kissing another man's wife. Let's go in after the big bum!

Second Window Washer: All right, how soon do you think he'll leave?

* * *

"So, you're a young man with both feet on the ground. What do you do for a living?"

"I take orders from a man with both feet on the desk."

* * *

Office Boy: Boss, you've been fussing about the men being late for work. I've got a plan that will guarantee that nobody will be late.

Boss: What's that?

Office Boy: Let the last man to work blow the starting whistle.

* * *

The two partners took the day off to shoot a little golf. On the fourth tee, one partner clapped his hand to his forehead: "My gosh, I forgot to lock the cash box!"

"So what?" said the other. "We're both here, aren't we?"

* * *

Sam: I thought you said your girl's legs were without equal.

Mike: No, I said they were without parallel.

It was one of those first dates.

"Cigarette?"

"No thank you. I don't smoke."

"Like to go down to Nick's and sip a few?"

"No. I don't ever touch alcohol."

"Well, let's go over to the stadium."

"No, please, let's not. I want to do something exciting, something new."

"O. K. Let's go to the dairy barn and milk hell out of a couple of cows."

* * *

"Your methods of cultivation are hopelessly out of date," said the youthful agricultural college graduate to the old farmer. "Why, I'd be astonished if you got even ten pounds of apples from that tree."

"So would I," replied the farmer. "It's a pear tree."

* * *

Office Manager: You were twenty minutes late again. Don't you know what time we start work in this office?

"No, sir, they're always working when I get here."

* * *

"How is Henry getting along with school, Eph?"

"Not so well, George, they're learning him to spell 'Taters' with a 'P'."

* * *

"Do you think you can make a good portrait of my wife?"

"My friend, I can make it so life-like you'll jump every time you see it!"

"This is a great country, Pat."

"And how's that?"

"Sure, the paper sez yez can buy a 'foive' dollar money order for three cents."

* * *

"I understand you've had your family tree looked up?"

"Yeah, and it cost $1005.00."

"Pretty expensive, huh?"

"Well it cost only $5.00 to have it looked up, but it cost $1000.00 to have it hushed up."

* * *

The reason Cupid makes so many bad shots is because he's aiming at the heart and looking at the hosiery.

* * *

"Is it possible for a man to make a fool of himself without knowing it?"

"Not if he has a wife."

* * *

About the time you learn to make the most of life—the most of it is gone.

* * *

Joe, the yardman, says he certainly has got a dumb ice man. The other morning he and his wife overslept and were awakened by the ice man coming into the bedroom looking for the ice box.

* * *

"What kind of toothpaste do you use?"

"None. My teeth ain't loose."

* * *

The wife of a Colorado mountaineer heard the clock strike thirteen times. She nudged her husband, saying, "Get up in a hurry, Zeke. It's later'n I've ever knowed it to be."

* * *

"How are you getting on at home since your wife went away?"

"Fine. I've reached the highest point of efficiency. I can put my socks on from either end."

* * *

The salesman was trying to "pick up" a beautiful blonde in the hotel lobby. She said, "Don't bother me." He said, "Pardon me, I thought you were my mother." She said, "I couldn't be, I'm married."

* * *

It seems that a girl and a boy were madly in love. So great was their love that when fate separated them and sent the boy to a distant city, he telegraphed messages of his devotion and affection each morning. Every day for three years the same Western Union messenger boy knocked on the girl's door, bearing the messages of undying love.

At the end of three years they were married—the girl and the Western Union boy.

* * *

"My husband plays tennis, swims and goes in for physical exercise. Does your husband take any regular exercise?"

"Well, last week he was out seven nights running."

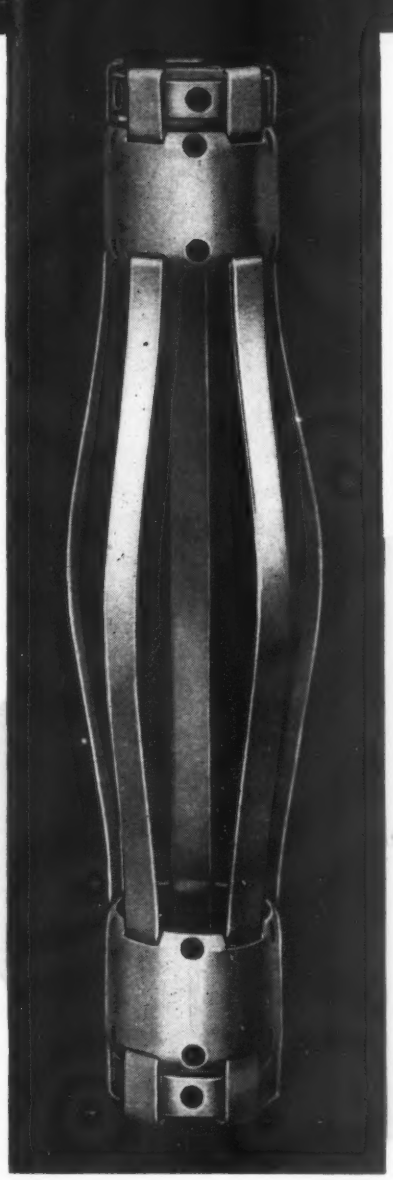
* * *

A man walked into a bar, sat on a stool and said to the bartender, "Give me something tall, cold and full of gin." Whereupon the man sitting on the next stool drew himself up straight and said. "Sir, I'll have you know you are speaking of the woman I married!"

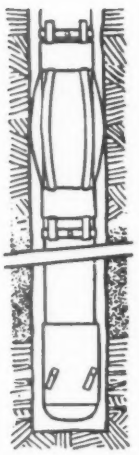
"You're either going to have to come down here and see for yourself or call LANE-WELLS and run a Radioactivity Log!"

LANE WELLS

You can't PUSH me around, but you can LEAD me wherever you like



And that is just one of the reasons for the outstanding success of the Baker Casing Centralizer! It is NEVER PUSHED either when the casing is being run into the well, or when passing collars while conditioning the hole and cementing. It is always PULLED through the casing or past any restriction in the open hole. Another important advantage is that the springs on Baker Casing Centralizers are *free to rotate around the casing* and are not forced to rotate with the casing if it turns while being run in the well. This means that the springs never tend to ball up and form a bridge from shearing the mud cake from the wall of the hole; they are not twisted, flattened, deformed or torn loose, but are ready to *hold the casing accurately centered in the hole* when cementing is performed.

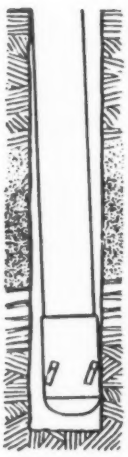


RIGHT and safe

At left the casing is accurately centered in the hole with Baker Casing Centralizers, so that a *uniformly thick* body of cement will surround the casing.

WRONG and dangerous

Here "channeling" will likely occur where shoe and casing contact the side wall of the hole, resulting in a *dangerously thin* cement sheath.



It's easy to start right

Just get in touch with the Baker representative nearest you for competent assistance in determining where Baker Casing Centralizers should be installed. They are quickly and easily spot welded on the casing by following simple directions given on the tag attached to each Centralizer. — And you then *know* that you are "well insured" against danger or failure when the cementing job is performed.

WHY CENTER CASING? It is inexpensive and positive insurance to place one Baker Casing Centralizer, Product No. 910 just above the shoe, and a sufficient number of Centralizers on the casing to be certain that the casing is centered in the hole over the entire vertical area to be cemented.

Wherever the shoe, or the casing, either *rests against* the side of the hole — or is *too close to the side wall* — you are in danger of channeling which usually results in cementing failure; see illustration above.

With Baker Casing Centralizers installed over the critical area, the casing is accurately centered in the hole, and conditions are most favorable for encasing the pipe with a uniform sheath of cement of maximum thickness — with best chances for success.

BAKER Casing Centralizer

Product No. 910

BAKER OIL TOOLS, INC.

Houston • Los Angeles • New York

G.P. new president

R. L. Minckler has been elected president of the General Petroleum Corporation, succeeding, on January 1, S. J. Dickey, who is retiring, it was announced at the company's home office in Los Angeles. R. A. Sperry, senior vice president and a director of the concern, also retired on that date.

Minckler was elected a G. P. vice president in 1945, upon returning from wartime service as director of petroleum supply of the Petroleum Administration for War. In June of this year he was advanced to the position of executive vice president. During the past year, he was one of three western oil men appointed by Secretary of the Interior Krug to the government's 15-man Military Petroleum Advisory Committee, whose function is to advise the Army and Navy on petroleum matters. He was also recently elected a member of the National Industrial Conference Board.

Born in Minneapolis, Minckler's first job was that of oil boy with the Great Northern Railway. He served in the Army during the first World War and subsequently attended the University of Washington, majoring in business administration. He then became a purser for a trans-Pacific steamship line and, in 1921, went to Southern California to work for the Southern California Edison Company as a cost accountant. He joined General Petroleum in 1924, became assistant to the president 10 years later, and in 1941 was elected a director. He was for several years a director of the Kettleman North Dome Association.

R. L. Minckler

S. J. Dickey

Dickey, whom he succeeds, has been president of General Petroleum since 1941. He first joined the company in 1919, after broad engineering experience following his graduation from the University of Pennsylvania in 1904. He progressed rapidly in the concern, being made chief engineer in 1920, a director in 1927, and vice president in charge of manufacture in 1930.

G-E promotions

Henry V. Erben has been elected a vice president by the board of directors of the General Electric Company, effective January 1, and on that date became general manager of the apparatus department, largest of the seven G-E operating departments, Charles E. Wilson, president announced recently. He succeeds Roy C. Muir, company vice president, who retired December 31, after more than 42 years' service.

John D. Lockton was elected treasurer of the company effective January 1, succeeding Jesse W. Lewis of New York who retired December 31, after more than 37 years' service.

Erben is now a commercial vice president and assistant general manager of the apparatus department, and Lockton is an assistant treasurer.

"Oilwell" changes

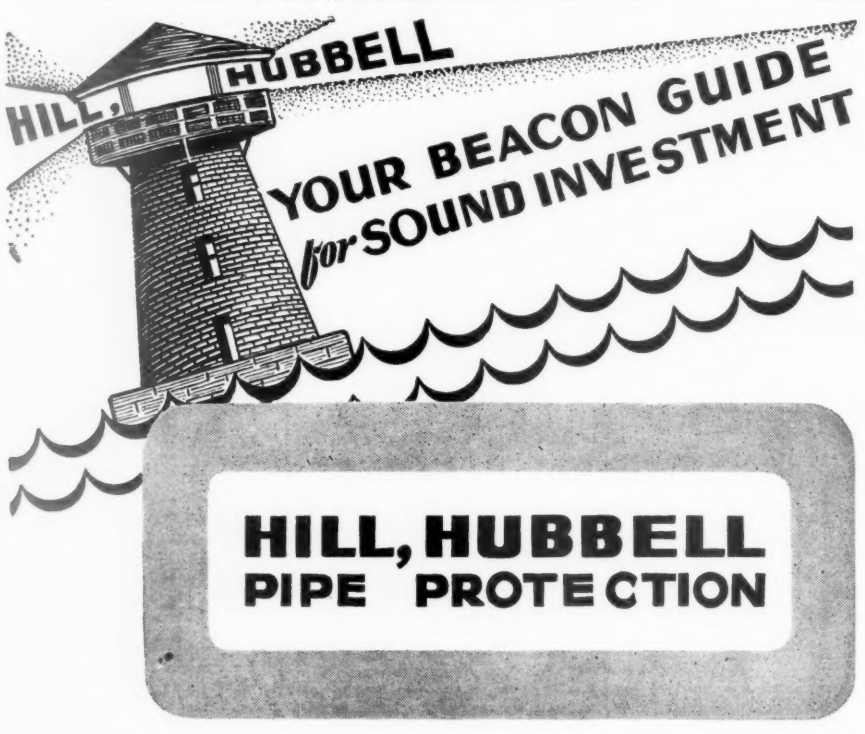
Several changes in Oil Well Supply Company personnel have been announced by K. B. Winstead, Central Midwest division manager for this U. S. Steel Corporation subsidiary.

Wayne B. Atkins, manager of the McCamey, Texas, store since March, 1947, has been appointed manager of the Big Spring ,Texas, store. He is succeeded at McCamey by Joseph M. Rogers, transferred from Denver City, Texas, where he held a similar position.

Carroll R. Jones, city representative at Midland, Texas, since January, 1946, has been named manager of "Oilwell's" store at Wichita Falls, Texas.

At Albany, Texas, Lloyd H. Fielder, who has been manager of that city's store since October, 1944, has been appointed assistant district engineer, subsurface equipment, with headquarters at Albany. His successor is M. F. Wellman, storeman in the Albany store for the last two years.

Winstead also reported that headquarters of C. R. Evans, district engineer, re-



better priming
● Because: The bare pipe is heated before being mechanically cleaned and accurately primed.

better coating
● Because: The properly primed pipe is again heated before being coated—and—wrapped to your standard specification; insuring positive bond of coating to the steel pipe.

better wrapping
● Because: The coating material is heated in thermostatically controlled and mechanically agitated kettles before being applied to the pipe, with the felt or glass mat being positively bonded to the coating.

in door processing
● All HILL, HUBBELL coating—and—wrapping is done indoors under scientifically controlled conditions, assuring quality work for your time induring and sound pipe line investments.

Hill, Hubbell and Company
Division of GENERAL PAINT CORPORATION
3091 MAYFIELD RD. CLEVELAND, OHIO.

finery and pipe line equipment, have been moved from Big Spring to Odessa, Texas.

Expand facilities

The Blackmer Pump Company, Grand Rapids, Michigan, announces that its Ohio sales representative, William Berrington and Son, Inc., has purchased an additional 7000 sq ft of warehouse space in Cleveland.

This addition, which is to be used to house a complete stock of Blackmer pumping equipment, is the third addition to Berrington facilities this year. Three offices, one in Cincinnati, Ohio, one in Columbus, Ohio, and the other in Indianapolis, Indiana, also were added.

It is also announced that the Berrington sales territory has been increased and now includes approximately all of the state of Ohio, southern Indiana, and northern Kentucky.

Made secretary-treasurer

W. A. Miller has been elected secretary and treasurer of Lane-Wells Company, succeeding Miss B. G. Peters, who has retired after 15 years' service.

Miller joined Lane-Wells in 1945 after 5½ years' service in the Army Air Force where he attained the rank of major. He has been chief statistician since January 1, 1946, and, in addition to his new duties as secretary and treasurer, will continue to head the statistical section. Miller will report to D. S. Jeppson, vice president and controller.

Heads I.P.

The Institute of Petroleum, London, England, announces that E. A. Evans, M.I.Mech.E.,F.Inst.Pet., has been nominated as president designate of the Institute for the session 1948-9. E. A. Evans, who has been chief chemist to the Wakefield Group of Companies since 1915, is well known in the field of lubrication. He has also been chairman of the Motor Industry Research Association since its beginning in March, 1946. He was chairman of its predecessor, the Automobile Research Committee, during 1944 and 1945 and chairman of its Research Sub-Committee from 1941 to 1943. In 1942-3 he was awarded the Crompton Medal of the I.A.E. for his paper on "Extreme-Pressure Lubrication."

B. S. Hull succumbs

Brice S. Hull, Pittsburgh branch manager of Solvay Sales Division, Allied Chemical and Dye Corporation, died of a heart attack on January 2. Hull, born in Van Wert, Ohio, was graduated from Ohio State University in 1914 with the degree of bachelor of science in chemical engineering, later completing graduate work there and at the University of Pittsburgh. He did technical service work for the Drackett Company until 1922, when he joined Wing & Evans in Cincinnati in a similar capacity. In 1923 Hull became Pittsburgh branch manager for Wing and Evans, remaining in that position when the firm was absorbed by Solvay Sales in 1927.

SIMPLE • EFFICIENT • DEPENDABLE

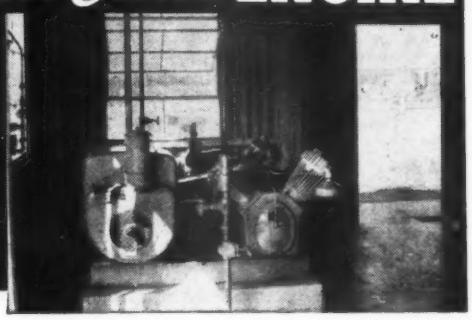
Designed by practical men, who know and appreciate the importance of removing shale from drilling mud, the S I W Rotating Mud Screen is the most complete unit of its kind on the market. With only one moving part, the rotating screen, this Mud Screen will give long service. So finely balanced is this mechanism that the power developed by the weight of mud falling from a one inch pipe will rotate the screen, yet the sturdy construction and capacity is sufficient to handle the flow from an eight inch pipe. Other features of the S I W Rotating Mud Screen are Mud By-Pass, sample catcher and chemical mixer, if desired. Made in three sizes, S I W Rotating Mud Screens give longer service at lower cost. Inquire now.

Sunshine Iron Works

601 W. MURPHY ODESSA, TEXAS PHONE 4374

WISCONSIN *Air-Cooled* ENGINE

On the Job at the New Lake St. John Gas-Cycling and Pressure Maintenance Project



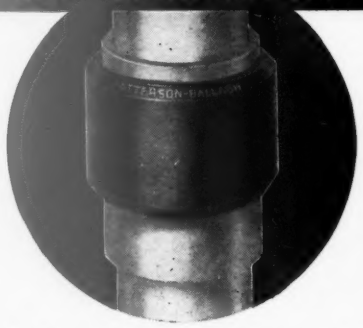
Included in the modern equipment employed by the California Company at the new Lake St. John Gas-Cycling and Pressure Maintenance Plant in Louisiana is this Wisconsin Model VE-4, V-type, 4-cylinder air-cooled power unit, driving a compressor. Here, in this new eastern Louisiana field where gas-cycling and condensate production, pressure maintenance and flush oil production are all combined, is located one of the most modern plants built to date. It is only logical, therefore, that the most efficient and dependable power equipment should be specified, in keeping with the high standards set by the designing and operating engineers.

Because Wisconsin Heavy-Duty Air-Cooled Engines deliver the maximum in Hp. Hours of on-the-job service, they can be depended upon to fulfill their power obligations even beyond the top limits of optimistic expectations. You can't go wrong when you specify: Wisconsin Air-Cooled Engines for any power job within a 2 to 30 hp. range.

WISCONSIN MOTOR Corporation
MILWAUKEE 14, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

WRITE TO HARLEY SALES CO.
510 Atlas Building, Tulsa, Oklahoma
M & M Building, Houston, Texas
Oil field distributors for Wisconsin Engines and all types of utility units.

"Best Bet Yet"
SAVE YOUR TUBING!



Tubing collars worn by contact with casing steal the profit out of pumping. Patterson-Ballagh Plastic Tubing Protectors prevent both collar and casing wear. Oil-proof, wear-resistant, insulating. They are pressed onto the collar under pressure and will not come off. Made in all sizes. End your tubing troubles. CALL in your Patterson-Ballagh man.

Specify "Best Bet Yet"
PATTERSON-BALLAGH
A Division of Byron Jackson Co.
PLASTIC
TUBING PROTECTORS

1900 E. 65th Street, LOS ANGELES 1
330 Russ Bldg., SAN FRANCISCO 4
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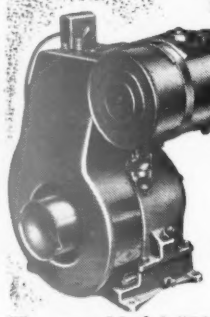
808 Graybar Bldg., NEW YORK 17

BEE-LINE ENGINES
The New Model 75



DESIGNED for UNIVERSAL USE

The new Model "75," incorporating the latest developments in engine design, is now in service where wide horsepower range and dependability are required.

Meehanite cast iron cylinder block, insert connecting rod bearings, Timken main bearings, air maze oil bath and low weight per horsepower are just a few features of the new "75."

ORDER NOW FOR PROMPT DELIVERY
For further information write:

Gladden Products CORP.
"28 years of engine building"
6351 West Colorado Blvd., Glendale 4, Calif

AIME holds meeting at Texas A. & M.

Among those present at the AIME meeting held recently at College Station, Texas, were: (l to r) seated: Albert Stevens, professor of petroleum engineering at Texas A & M, and chairman of the program committee for the meeting; Harold Vance, professor and head of the Department of Petroleum Engineering at Texas A & M, and host for the meeting; Dr. George Fancher of the Department of Petroleum Engineering at the University of Texas; standing: Harry Power, professor and head of the Department of Petroleum Engineering at the University of Texas, and a member of the program committee for the meeting; I. W. Alcorn, The Pure Oil Company, Houston, chairman-elect for the Petroleum Division of the AIME; James A. Clay, Jr., Service Engineers, Inc., Fort Worth, author of one of the papers given at the meeting; R. S. Christie, Amerada Petroleum Corporation, Fort Worth, and vice chairman of the North Texas Chapter of AIME, and D. V. Carter, Magnolia Petroleum Company, Dallas, author of one of the papers given at the meeting.

More than 250 people attended the sessions and dinner at the second annual 2-day regional meeting. Col. T. H. Barton, chairman of the board, Lion Oil Company, El Dorado, Arkansas, was the principal speaker at the dinner. He was introduced by H. J. Gruy, DeGolyer and MacNaughton, Dallas, who served as toastmaster. The Gulf Coast Section's prize was awarded to Joe L. Hargrove, student at the University of Texas, for his preparation and presentation of a paper entitled "Radioactivity Well Logging." The prize, a check for $50, was presented by Harold Decker, chairman of the Gulf Coast Section. William Strang, secretary of the Petroleum Division, AIME, announced an award of $25 to T. J. Tighe, student at A & M, for his paper in the student contest entitled "Acidization of Producing Formations."

Promotions made

Two appointments in the headquarters sales department of American Steel and Wire Company, United States Steel Corporation subsidiary, have been announced.

Charles W. Meyers, who began work in the company's Cuyahoga Works as a chemist in 1923, was named director of spring sales in the manufacturers products sales division.

He attended schools in his home city of New Philadelphia, Ohio, and then was graduated from Case School of Applied Science, later receiving his master's degree in business administration from Harvard University. After several years as a chemist with American Steel and Wire, he was named instructor in the company's educational department, and later development engineer. During the war he served as special representative on aviation products and in 1946 was named assistant manager of the wire rope and construction materials division.

The other appointment names Edwin T. Eggers to the latter position, succeeding Meyers. Eggers, who attended schools in Rutherford, New Jersey, and was graduated from Pennsylvania State College, started with American Steel and Wire Company in 1934 after five years with several engineering and construction companies.

He served as a salesman in the company's Philadelphia office for a year, and then in the Chicago district sales office from 1935 until 1943. He has served since that time as the company's special representative in the Mid-Continent oil fields.

Cameron Iron host

The Purchasing Agents Association of Houston was the guest of Cameron Iron Works at a luncheon in the Cameron dining room on December 17. More than a hundred members of the association attended and were conducted on a tour through the Cameron manufacturing plant situated on Katy and Silber Roads in Houston. Highlight of the plant tour was a visit to the new Cameron forge shop, which was in full operation at the time. The Cameron forge shop is reputed to be one of the largest and most modern plants of its kind in the nation.

Joins Weatherford Spring

J. E. (Jimmy) Berry, former drilling superintendent for Shell Oil Company, Inc., has resigned to become vice president of Weatherford Spring Company of Venezuela, C.A., distributors of oilwell cementing tools operating internationally. Berry has been connected with the oil industry since 1933 having worked in Texas, Louisiana, and for the last ten years in Western Venezuela as driller, toolpusher, and drilling superintendent.

J. E. (Jimmy) Berry

Los Angeles manager

Appointment of George A. Baldwin as manager of the Los Angeles sales office of Blackmer Pump Company has been announced.

Before joining the Blackmer organization, Baldwin was associated with the William W. Garrison advertising agency of Grand Rapids, and prior to that was advertising manager of the Insulox Division of Owens Illinois Glass Company.

Baldwin is a graduate of the University of Illinois, from which he holds a bachelor of arts degree in advertising.

Los Angeles offices of the Blackmer organization are at 415 South Central Avenue. Home offices of the company are in Grand Rapids, Michigan.

Purchase tool rights

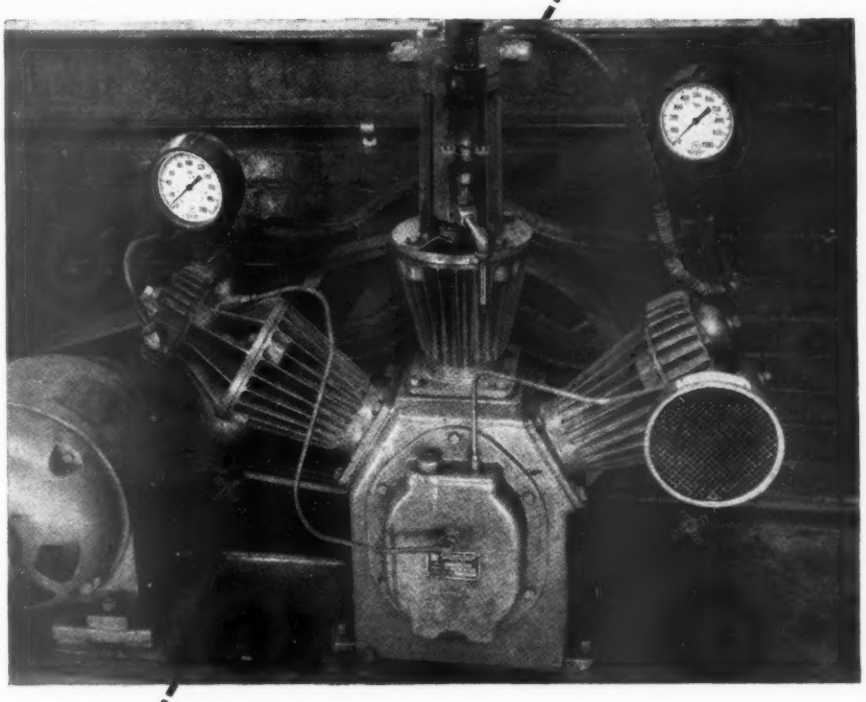
Purchase of exclusive manufacturing and distribution rights to the Roofe swivel joint, in domestic and foreign fields, is announced by Hunt Tool Company, Houston, Texas. T. N. Hunt, president of Hunt Tool Company, said in making announcement of the purchase that Hunt Tool has taken over the entire production of the Roofe swivel joint along with some shop production equipment and shop personnel of the Roofe company.

Additional new specialized production equipment will be purchased and installed immediately in order to greatly increase output of the Roofe swivel joint for the oil industries, Hunt said.

Sales of the Roofe swivel joint in domestic fields will be handled through Hunt Tool Company. Export sales will be handled by Hunt Export Company, with offices in Houston, New York, Buenos Aires, Port of Spain, and Mexico City.

Roofe swivel joints have been used throughout the oil industry for more than two years. The joint features a patented packing and bearing design that makes it easy to assemble or disassemble on the derrick floor, a full size streamline bore through the joint, a specially designed packing chamber that permits lubrication under pressure, and a bearing area that assures perfect alignment of all working parts.

Here's how HELICOID GAGES

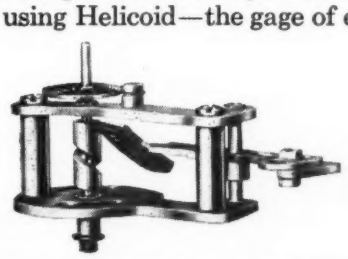


PAY OFF!

On a compressor like this, where you have vibration and rapid pressure pulsations, ordinary gages with clock gear movements last but a short time. Sometimes the gears are worn out in a few weeks.

By comparison, Helicoid gages wear for years. Actually, the gages shown here have been in service for 2½ years and are still going strong.

This is an example of the saving in maintenance which can be made by using Helicoid—the gage of enduring accuracy.



Only Helicoid gages have Helicoid movement

ACCO

TRADE MARK

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE
Bridgeport 2, Connecticut

District manager

Ward C. Whippo nas been appointed district sales manager for the Pittsburgh district of Reading-Pratt and Cady Division of American Chain and Cable Company, Inc., with headquarters at 908 Empire Building, Pittsburgh 22, Pennsylvania.

Reading-Pratt and Cady Division manufactures brass, steel, and iron valves and steel fittings.

Whippo, who has been with the company for 10 years, succeeds A. W. Taggart who was district sales manager for many years and has retired.

H. O. Pierce dies

Harral O. Pierce, manager of the Charlotte, North Carolina, branch office of Solvay Sales Division, Allied Chemical and Dye Corporation, died December 28 of a heart attack following a brief illness. Pierce joined the Solvay organization in 1910 in the paymaster department of the Solvay Process Company, where he remained until 1915 when he became a partner in Snell and Pierce, jobbers of laundry supplies. This firm was absorbed by Solvay Sales in 1922.

De Olen Pugh dies

De Olen Pugh, Byron Jackson Company, Tulsa, Oklahoma, died unexpectedly January 11 at his home, 1724 West Cameron Street. Pugh was born in Ranger, Arkansas, March 31, 1901. His family moved to Tulsa in 1929. He joined Byron Jackson Company from Dunn Manufacturing Company, which he joined in Tulsa in 1926.

STEP UP

Steam Pressure

And Lessen Tube Failure

SAND-BANUM

Removes and Prevents Boiler scale and corrosion regardless of water or operating conditions. Does not carry over with the steam.

★

YOU GET

Peak Load Efficiency, fuel economy, longer equipment life, fewer shut-downs.

★

WRITE FOR "In the Palm of Your Hand"

"The Entirely Different Boiler and Engine Treatment"

AMERICAN SAND-BANUM COMPANY, Inc.

9 ROCKEFELLER PLAZA, NEW YORK CITY 20

Service manager

James F. Lincoln, president of The Lincoln Electric Company, Cleveland, Ohio, announces the appointment of G. E. Tenney as service manager to direct the policies and operations of a newly expanded service department. To the task of creating an organization to handle the servicing of Lincoln equipment on a national scale, Tenney brings the experience of 15 years as district manager for the Lincoln Chicago office. It was largely through the efforts of Tenney and his staff that the use of arc welding as a cost reducing production tool was greatly expanded in the industries of Chicago.

G. E. Tenney

Previous to coming to Lincoln in 1932 he was the sales manager for the Moore Drop Forging Company of Springfield, Massachusetts, with whom he had been employed since his discharge from the Army in 1922.

Key appointments

Frank V. Long, president of The Vapor Recovery Systems Company, announces the appointment of L. S. Curfew as executive vice president; Joseph F. Lee as general manager, and George F. Denny as chief engineer, effective January 1.

Curfew has been with The Vapor Recovery Systems Company since its inception in 1928 and has progressively advanced through the positions of field superintendent, shop superintendent, plant manager, and general manager.

Lee, former chief engineer, advances to the position of general manager. Lee served as chief machinery engineer with the California Shipbuilding Corporation during the war and prior to that was with the Design Section, Bureau of Engineering, U.S. Navy for 12 years.

George F. Denny, who replaces Lee as chief engineer, was a former development engineer with The Vapor Recovery Systems Company. He too served in an engineering capacity with California Shipbuilding Corporation during the war and before that spent 13 years with the refining department of The Texas Company.

Sentner promoted

Appointment of Richard F. Sentner as assistant vice president-sales, United States Steel Corporation of Delaware, effective January 1, was announced by David F. Austin, vice president.

Sentner began his business career with the Wheeling Steel Corporation in 1926. He was appointed manager of tin plate sales for the company in 1941. In 1942 he joined the War Production Board and later was appointed deputy director of the steel division. Sentner returned to the Wheeling Steel Corporation as assistant manager of sales in October, 1945.

On business trip

George A. Anderson, manager, and Allison C. Dyer, chief engineer, of Oil Weigh Meter Company, left Los Angeles, California, January 13, to make a swing through Texas, Oklahoma, and Louisiana, visiting the oil fields in these states. The purpose of the trip is to make arrangements for the manufacture and more extensive distribution of Oil Weigh Meters in the Mid-Continent and Gulf Coast fields. The growing demand in these areas has necessitated the opening of a branch factory with adequate representation, they state. An analysis of all the factors has indicated to the principals that the needs of the operators could be best served from some Texas center, such as Houston or Dallas.

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"Oilwell" advances four

The appointment of M. F. Hazel of Dallas as general manager of sales for the Oil Well Supply Company, U. S. Steel subsidiary, is announced by Lloyd E. Tracy, sales vice president.

M. F. Hazel

K. B. Winstead

V. J. Waters

C. A. Bell

At the same time Tracy announced the appointment of K. B. Winstead, also of Dallas, as assistant general manager of sales, with headquarters at Dallas.

V. J. Waters was named manager of the Central Midwest division of Oil Well Supply Company with headquarters in Dallas.

C. A. Bell was appointed manager of drilling equipment sales, also with headquarters in Dallas.

Hazel, a native of Bellefonte, Pennsylvania, and a graduate mechanical engineer from Penn State College, became associated with Oil Well Supply Company in 1930 as service engineer. From 1930 until 1943, he served in various capacities in East Texas and Oklahoma, becoming sales manager for both the West Texas and the East Texas-North Louisiana-Arkansas districts. In 1941, he was assistant division manager at Houston. In 1943 he entered the United States Navy with the rank of lieutenant. He returned to Oil Well Supply Company in 1946 as assistant to the vice president.

Hazel will be responsible for coordinating sales activities of the domestic and export divisions and the tubular department.

Winstead, a native of Weatherford, Texas, became connected with Oil Well Supply Company in 1921, and has been located at Fort Worth, Breckenridge, Wichita Falls, and at Dallas. He has served in various capacities, in 1946 becoming manager of the then Central Midwest division.

Waters, a native of Hartford City, Indiana, joined the "Oilwell" organization in 1919. He has served at Cushing, Wynona, Bryant, Shidler, Okmulgee, Wewoka, and Tulsa, Oklahoma, and has been stationed in Dallas since 1932.

Bell, native of Mississippi, began work with "Oilwell" in 1924.

WOGA officials

Western Oil and Gas Association has elected its board of directors and officers for the calendar year 1948. At its annual meeting recently held in Los Angeles the association membership determined the following for directors: C. R. Allen, Leigh M. Battson, S. Belither, James B. Black, Harold L. Briggs, H. D. Collier, J. A. Crawford, S. J. Dickey, E. S. Dulin, Rodney S. Durkee, Leroy M. Edwards, R. P. Huggins, Wm. F. Humphrey, C. A. Johnson, C. S. Jones, W. M. Keck, Ralph B. Lloyd, A. C. Mattei, S. B. Mosher, William Reinhardt, L. P. St. Clair, J. B. Sutherland, Reese H. Taylor, C. P. Watson, Torrey H. Webb, A. L. Weil, W. C. Whaley, and L. K. Whittier.

Association officers elected are: Ralph B. Lloyd, president; William Reinhardt, first vice president; Wm. F. Humphrey, second vice president; L. K. Whittier, treasurer; Don E. Gilman, executive vice president; David S. Kilgour, secretary; George F. Prussing, technical secretary, and John M. Peirce, economist.

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Petrolic Personalities

By DICK SNEDDON

Here it is only January second as we write and already the din occasioned by the fracturing of countless resolutions has reached such a pandemoniac crescendo that there are not enough decibels in all the sonic laboratories of the United States to measure it. George Washington Carver, the ebony genius of Tuskegee, is greatly honored of men because, among other things, he found a multitude of uses for the lowly goober. Imagine then the adulation and acclaim that would fall to the lad so clever, or so fortunate, as to discover just one single good use for old broken resolutions. Why, he would not only make a fortune, but would become a national hero, possibly exceeding in public favor such doughty characters of other years as the champion flagpole sitters and the marathon dancers. Who knows, he might have an oil zone named after him! Well, anyway, it is interesting to let one's mind run amok in such elevated channels once in a while, just by way of a change. Wherewith, we are resolved to abandon, and for all time, the subject of resolutions.

●

Referring specifically to the petrolic scene, we have for some months been sitting in on periodic meetings with a group of export men who make it their business to keep track of the comings and goings of persons engaged in foreign fields. This snug little coterie is led by Jerry Engstrand of the Grant Oil Tool Company, one of these "man-about-town" fellows who seems to know everybody and his brother between Caracas, Venezuela, and Oshkosh, Wisconsin. He may not own the Jonathan Club in Los Angeles, but he certainly has a terrific interest in the place, and if it wasn't for Jerry, the Club could certainly dispense with its page boys. He gets more mysterious phone calls than the parents of a kidnaped baby, and is mixed up in more enterprises than Bing Crosby.

Also a member of this group is Vernon Mitchell, representing Security Engineering, and fairly recently returned from a sojourn in the oil fields of Alberta, Canada, where for the first time in his life, during the much below zero winter months, he saw crude oil being sawed into square blocks and carried to the production department on flatbed trucks. "Mitch," as he is better known in them parts, declares that when you drive into a service station in the far northwest in winter, the attendant doesn't say, "Shall I fill 'er up?" he simply asks, "How many lumps, please?" Speaking of Security Engineering reminds us that Bob Cook is back from an extensive visit in South America, and doesn't look a bit the worse for the adventure. As a matter of fact, any committeeman who managed to survive the rigors of office at the drilling contractors' convention at Long Beach is strong enough constitutionally to take a trip around the world on a pogo stick.

Returning to the export meetings, also present usually is Ted Forsyth, the Emsco sales and export biggie, who has added tremendously to the pleasure of the Petroleum Production Pioneers' gatherings ever since the inception of the institution, by his generous and capable dispensing of the singing waters. Incidentally, it happened that some time ago we consorted briefly with a neat little assortment of oil men at the Virginia Club in Long Beach, among them Frank Hill, retired director of production for Union Oil Company, and the west's best rememberer of early California oil history; Doc Hayes, the front half of Hayes and Sprague, drilling contractors; Ed Masters, Shell Oil Company production chief; and the aforementioned Ted Forsyth. This clambake was hosted by Elmer Decker, one of the most prolific hosters on the Pacific Coast, and it came out during a barrage of small talk that Deck and Ted, by the strangest coincidence, were both born in the year eighteen hundred and something, and on the very same day, if you please. The precise annum that witnessed this queer occurrence is lost in a haze of antiquity, but there is no question whatever about the day. It was April first, sometimes erroneously called, "All Fools Day". We have looked into the origin of this odd name and find that the whole thing is what we call

in French *pate de foie gras* or words to that effect. Actually the day was first known as "Oil Tools Day," but as frequently happens, the phrase was bandied about so carelessly and repeated so endlessly down the years that it suffered a relapse and finally debauched to its present silly form. Anyone conscious of the success of these two business behemoths would know that the vulgar appellation, "All Fools Day," is a rank misnomer.

●

On the subject of names, there has been much debate in California oil circles about the Chonette brothers—high in the production end of the oil business, one with The Texas Company and one with the Shell Oil Company, and both, strange to relate, named Bill. Ring Lardner once expressed somewhat sadly the wish that he had named all his boys John. He felt that if he had done so, when he called, "John!" there would at least be a remote chance of one of the kids showing up. Scenting a similar story in the Chonette case, we quizzed the Texas Bill recently and as nearly as we can remember these are the facts: Both of the Chonette boys are really named William. It is the first name of one and the second name of the other. The one who has it for a second name doesn't like his first name. The one who has it for a first name doesn't like his second name, so they both use William, and are both known as Bill. Reminds us, for no particular reason of Mark Twain who, when the Bacon-Shakespeare controversy was at its height said he didn't believe Shakespeare wrote the plays at all "but another man of the same name."

●

With this issue of the keyhole kolumn we spread our editorial wings and reach out daringly into the remotest derrick groves and doghouses in the land in search of new victims. Nothing, no matter how distant, shall longer be beyond the focal range of our discerning eye, and no person, be he ever so obscure, shall be immune to the analytical animus of our trusty Royal portable. For example, we hear tell that five civic minded Texans sat far into the night following a recent AIME meeting at College Station on the Texas A & M campus. They busied themselves shuffling and distributing sundry pasteboards, bearing the most unpredictable designs. This form of art, we are told, is practiced widely by the natives of the Lone Star State. It is accompanied by the exchange of red, white, and blue disks, and the muttering of such weird imprecations as, "Gimme two," "I'll stand on these," and "Son of a gun, I wisht I had stayed, I coulda beat the both of you!" However, to get to the crux of the situation, two of the principal contesants in this particular battle of wits were George Cannon and R. C. Granberry, a couple of Humble (in some respects) engineers. After a term of fencing for an especially bulgy pot this pair were obliged to divide the loot, having each hugged fondly to his chest a low hand of precisely the same value—10-7-6-4-3, a rare circumstance, indeed, fully justifying the vigorous aspersions they hurled at each other when the showdown came.

●

On December 4, also at College Station, one I.W. "Al" Alcorn, chairman elect of the petroleum division of AIME, and an engineer of good repute on the staff of Pure Oil at Houston, parked his nice new Pontiac and proceeded to the AIME banquet, practicing his speech—in case he should be called upon —*sotto voce*. When the shindig was over, he came out to the campus again, eager to get his hands on the wheel of his glistening chariot, but not a sign of it could he find. He was a trifle hazy as to where he had left it, and getting more frantic by the minute, he peered and poked everywhere around the campus for a couple of hours. Then, in desperation, he phoned Harold Vance and was informed that he had parked a hundred feet or so behind the Aggieland Inn, whence he hastened and found it without further delay. And what a relief that was, even if he did in the meantime miss a couple of hours of the fun at the La Salle hotel where he was quartered. It all reminds us of our Uncle Angus who lived in a trailer and could never find his bull fiddle when he had a playing date.

●

Some day we are going to compile a list of petrolic golfers who have achieved distinction on the links, like for example, Bill Bettis, the M. O. Johnston Company divoteer, on one of whose divots the Chevy Chase golf shop in Glendale was built. Then there is Ralph Clemons, the Bethlehem Supply excavator, who does most of his digging at the San Gabriel Club

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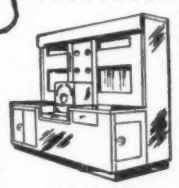

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near Los Angeles. Ralph is said to be able to miss a spoon shot with such terrific force that you would actually think he was missing it with a driver. Which brings us around to the case of Jack Creighton, the DeGolyer and McNaughton engineer from Dallas, who carved himself a niche in the hall of fame with a four iron a short time ago out at the Bob-O-Links course. He was playing with Glenn Woodward, another DeGolyer and McNaughton whiz, and they came up to the eighth tee all bubbling over with ambition and stuff. A nasty cross wind was blowing but what do engineers care about nasty cross winds? The boys simply took out their slip sticks, made a few rapid resistance calculations, and smiled superciliously—right into the face of the wind. Glenn then stalked majestically to the tee, took his stance, and belted the pill out in just the right parabolic curve to land it a scant three feet from the cup. Being an engineer, of course, he was bitterly disappointed. Up comes Jack, spreads his brogans, winds up like a helical spring, and then, just when he appears to be in a hopeless tangle, suddenly unwinds again with a whirr like a frightened quail. His ball sails out beautifully and appears to be going straight, but when they reach the green it is nowhere in sight. They search almost as long as Al Alcorn did for his Pontiac but to no avail and are just about to give up when Jack takes a look in the cup and bless his soul if the ball isn't lying in there as snug as could be, just as if it had rented the place. Well, anyway, Jack is now a member of that exclusive band known as the hole-in-one club, and we understand he is not speaking to every Tom, Dick and Harry these days.

●

Comes word of another Texan who wears the garland of a hero not for his prowess on the bowling alley or the golf links but because of his capacity to stand strongly on his feet under conditions that laid everyone around him lower than the proverbial whale's umbilicus. Warren Jackson, a Lane-Wells perforator with right keen penetration, is the laddie about whom this skein of yarn is wound. It seems that during a flying jaunt from Dallas to Los Angeles, the American Airlines plane on which he was traveling ran into extremely choppy weather. Practically everybody on board became air sick, including the stewardess. But Warren has often flown over Washington, D. C., where the updraft from the House of Congress is stupendous, so he wasn't even mildly disturbed by this juvenile squall. In fact, he put on an apron, took over the kitchen and in general performed so adequately that he was thereupon and thereafter dubbed Assistant Stewardess Jackson. The oil industry ought to have some special form of recognition for those of its members who, outside the scope of their regular duties, acquit themselves with unusual distinction. If it ever does, we shall remember to nominate Warren for the double O, meaning "oil oscar."

●

Incidentally, while we are in Lane-Wells territory, we might mention that we found Jim Hughes tucking into a mess of pottage at the Los Angeles Athletic Club the tother noon, and looking fit enough to indicate that he had celebrated Christmas with decorum and wisdom. Certainly his appetite was not adversely affected. Which recalls that a Colorado oil executive (name withheld pending confirmation) who has been laid up with acute indigestion for the past month is now so far recovered that he can eat things that don't agree with him again. Also, in passing, we would like to say that the Lane-Wells Christmas card this year was both novel and impressive. It was just a nice friendly wish on a large card—signed by all the employes. Continuing on the Christmas spirit, we received from Wally Curtis, the General Petroleum public relations chief, as nice a selection of good cheeses as we have ever set eyes on—or teeth into. It came from the Swiss Colony in Wisconsin, and we have been yodeling with sheer joy ever since it arrived. In the little Gourmet's Guide that accompanied the passage, it said that one of the cuts was taken from a huge cheese wheel weighing 75 pounds. That is a big cheese all right, but still not quite as big as the ones that bet on USC in the Rose Bowl.

●

Now for the last minute roundup: We had an elegant time at the Youngstown-Emsco cocktail party at the Ambassador Hotel in Los Angeles, not that we care for cocktails—the feathers are so irritating. But, we met just oodles of friends from

von and hither. Frixample, we sat at the round table with Tommy Atkinson, the recently elevated flying horseman; Ward Kelley, from the Bakersfield branch of the same institution; Jim Moon who fishes for Waldrip Engineering Company; Charley McClure and John DeHetre, Youngstown scions, and all told a group with more piscatorial savvy than old man Walton himself. We heard quartets by the scad. One with which we joined briefly, included Bill Kinder, the Emsconian and Paul Huggins, the Western Gulf southpaw, who never digs a divot weighing less than ten pounds. They were doing such sweet warbling on this occasion, however, that we thought it advisable to move on before they discovered that we had a rasp lodged in our thorax. Among our hosts we managed to say hello to Hugh Glenn, Dick Whelan, Ted Forsyth, Renie Fowks, and a dozen and one other, but there were just too many to tell about here, so for the nonce, and with apologies to those we missed, adios, and Happy New Year!

In business 25 years

The end of 1947 rounded out a quarter century of service to the oil industry by the MacClatchie Manufacturing Company, Compton, California. The growth of this firm from its beginning in 1922, in a one-car garage structure in Brea, California, to its present complete plant in Compton is a story of pioneering and growth that parallels the rise of the petroleum industry.

The MacClatchie firm was first to introduce many of the important features of present day mud pump valves and pistons, including such features as the hardened and ground valve seat, the cup type replaceable piston rubbers, and similar improvements.

The firm is still headed by its founder, J. Warren MacClatchie, who initiated the original business to manufacture oil field specialty items. In 1923, only a year after the firm's beginning, MacClatchie realized that the fast-growing petroleum industry would require increased specialty tool facilities, and he moved the plant to Compton.

In the last 25 years, MacClatchie has built the firm up to its present position as one of the leaders in the business, selling oil tool equipment throughout the world.

J. Warren MacClatchie is not only a recognized figure in the petroleum industry, but is also noted as a breeder of fine thoroughbred horses. He maintains a stable of racing horses and a large ranch in southern California devoted to breeding and training of race horses.

Enters cementing equipment field

Cameron Iron Works, Houston, Texas, has announced the purchase of all the fixed assets of the Nuwell Tool Company, also of Houston, effective December 15. According to the announcement, the Nuwell Tool Company, under the terms of the purchase, will be dissolved and the Nuwell line of "Flo-Master" float collars, float shoes, and other cementing equipment will be manufactured and marketed by Cameron Iron Works.

Cameron Iron Works is one of the industry's pioneer manufacturers of drilling and completion control equipment. In recent years, the company has added a number of other specialties, which have combined to make Cameron one of the major oil tool producers in the nation.

Commenting on his company's most recent venture, E. L. Lorehn, vice president and general manager, pointed out that the acquisition of the Nuwell cementing equipment is another step in the Cameron program for expanding and diversifying its manufactured products.

Assumes new duties

M. O. Johnston Oil Field Service Corporation announces that M. O. Johnston, Jr., is now in charge of outgoing and incoming supplies and equipment at the main office and plant in Los Angeles, California.

After graduating from Southern Methodist University, M. O. Johnston, Jr., spent some time with the Johnston Corporation at Los Angeles. During the war he served in the Marine Corps and saw action at Guadalcanal, Saipan, and Guam. At the end of hostilities he returned to the corporation's employ and recently has been on a leave of absence taking specialized business training preparatory to assuming his new duties.

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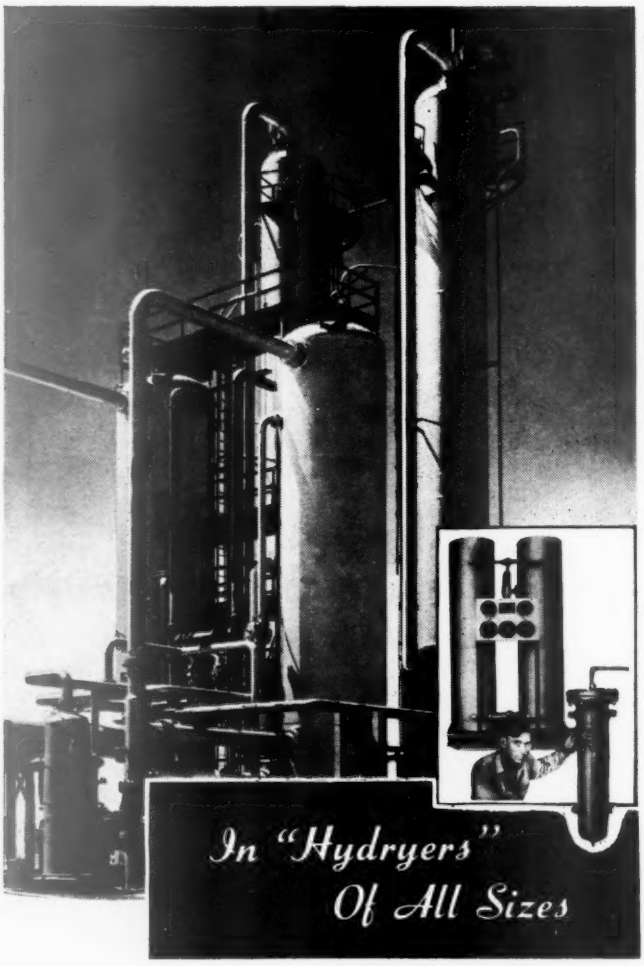

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Hydril blowout preventer demonstrated

Showing the new Hydril Type "GK" blowout preventer in operation, a newly completed demonstration truck is now touring the oil fields.

Mounted in the enclosed body of the truck is a 10-in. Series 900, 6000 psi test Type "GK" blowout preventer and equipment for operating it under pressure. The demonstration includes closing the packing element on a square kelly, drill

pipe and tool joints, stripping tool joints, and closing as an emergency gate, all under high pressure simulating field conditions. Large panel displays show the blowout preventer in cross-section under the various operating positions, aiding the viewer in visualizing the functioning of tne equipment.

The demonstration unit will visit the West Texas-New Mexico areas next proceeding to the Mid-Continent fields, and later covering the Gulf Coast.

Pioneers' year-end roundup

The Petroleum Production Pioneers Year-End Roundup at the Los Angeles Breakfast Club on Saturday, December 13, 1947, brought approximately 500 oil men, old timers and young timers, together in an evening of consorting and remembering that appeared to be thoroughly enjoyed by all. The affair opened with a cocktail hour, during which inhibitions, if any, were completely dispelled, and everybody became well acquainted with everybody else. Incidentally, Chris Christanelli, Baroid's public relationist, came from Houston with his concertina to help the impromptu warblers stay on the right key, and was very successful despite the difficulty of his assignment. George Trembley, Ted Forsyth, Hudson Drake, Clint Eddleman, Lee Laird, and Tommy Atkinson, officiated ably behind the soda fountain, and did their usual competent job of dispensing liquid refreshment.

Ox Morgan and Larry Coker, in charge of arrangements, provided steak dinners for the occasion, and it was a fine representation of the drilling and production industries that sat down to a half hour of uninterrupted good eating. After dinner, Ox Morgan opened the meeting by calling upon Jim Gosline, president, for a few remarks. The latter gave some interesting statistics with regard to the growth of the organization, which now numbers some 800 members. He also announced the fact that Articles of Incorporation had been approved by the Secretary of State, and finished with a dissertation on the aims and objectives of the Petroleum Production Pioneers.

Dick Guiberson, honorary president, then spoke briefly in behalf of the old timers, and gave his usual eloquent address. He was roundly applauded for his eulogy of the early operators and the part that they had played in the building of the California petroleum industry, and as a special tribute to Dick personally, he was first obliged to recite his own poem, "The Pioneers," which has graced the inside cover of the association roster book for the past two years, and was finally elected to lead the assembly in "Auld Lang Syne," before the party broke up. Dick is an old concert singer and can still do a high class job.

W. L. "Bill" McLaine, honorary vice president, was then introduced and in turn presented the following old timers: A. E. Fowks, Union Oil Company, retired, a veteran of 74 years in the industry; General Peeler, once president of California Petroleum Corporation, now retired; R. C. Baker, Baker Oil Tools, Inc., 53 years in the oil business and still active; Frank Dinger, National Supply Company, retired, for many years the industry's jar expert; Ben Youngken, National Supply Com-

pany, retired; Ed Stearns, Universal Consolidated Oil Company; W. O. Todd, erstwhile Standard Oiler and drilling contractor; E. C. Bolton, Ohio Oil Company, retired; John Crawford, 63 years of industry activity, now chairman of the board of directors of Parkersburg Rig and Reel Company, and looks young enough to go another 63 years; Lin Little, Standard of California, retired, first honorary president of PPP; Ben Howe, 53 years in the industry, associated with E. L. Doheny in his early operations, and later with Esperanza Oil Company, forerunner of the General Petroleum Corporation. Also at the head table was R. C. Stoner, vice president of Standard Oil Company of California, a regular attender at all PPP functions, and a gentleman whose support has been given generously to the organization almost since its inception.

After dinner a color motion picture, "The Last Frontier," was presented and thoroughly enjoyed. This picture gives some intimate glimpses of Arabian-American operations in Saudi-Arabia.

L. A. Nomads' closed session

The Los Angeles Chapter of Nomads held its annual closed meeting at the Jonathan Club on December 10, and a right good time was enjoyed by a substantial representation of the membership despite the intrusion of business into what is normally a completely social affair. Leland Laird, the sergeant-at-arms, brought a lady accordionist out to accompany the impromptu quartets that always bloom so profusely at the Nomad functions during the early part of the evening, so the attention of the gathering wasn't entirely concentrated on numerical figures.

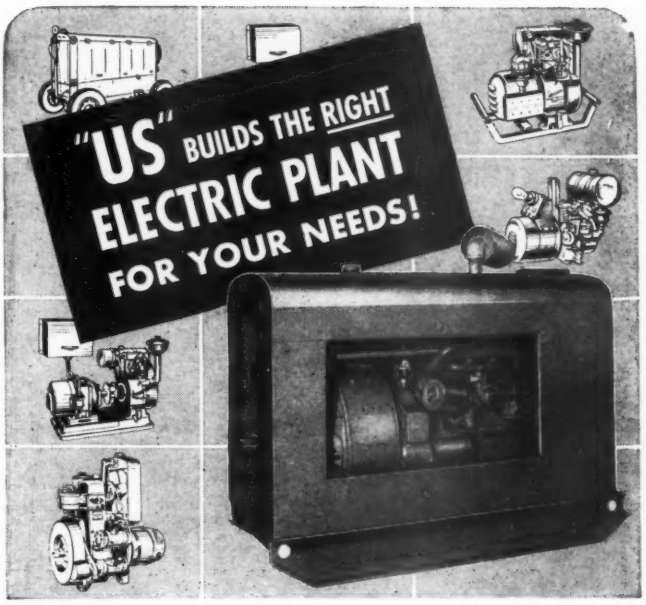
With Bob Eiche in the chair, nomination of officers for 1948 was one of the most important items on the agenda, and the following were designated as candidates: President, Fred Ripley, Jr., and Earle Boggess; vice president, Lee Laird; secretary, Byron Landis; treasurer, B. Reinhold; sergeant-at-arms, Earle Boggess; assistant secretary, George Flanders; assistant treasurer, John Flanagan; deputy sergeant-at-arms, Jerry Engstrand. Ballots have been mailed to the members and results will be announced at the January 14 meeting.

Left to right: Howard Tinkham, Dick Sneddon, John Regan, Vernon Mitchell, Kinzie Miller, and Elmer Decker.

The International Petroleum Exposition at Tulsa came in for considerable discussion and members expecting to go there were asked by Ted Sutter to inform Byron Landis of the fact, so that a reception committee might be appointed to serve at the show. Ted also announced that the first issue of the new Nomad publication would be off the press in time for distribution to the delegates at Tulsa, and would thereafter be published quarterly.

It was announced that the Board of Regents in Chicago had approved the election of Ned Brown, president of Brown Drilling Company, and national president of the American Association of Oilwell Drilling Contractors, to honorary membership in the Los Angeles chapter. Arrangements are being made for a formal presentation at a future meeting.

During the evening, five new associate Nomads were initiated



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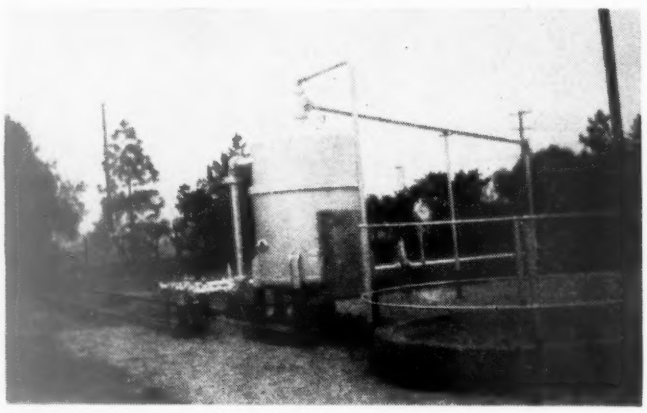

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into membership by Elmer Decker, one of the founders of the Los Angeles chapter, and an indefatigable worker for the cause. The initiates were J. Howard Tinkham, Dick Sneddon, John Regan, Vernon Mitchell, and Kinzie Miller.

B. Reinhold made an appeal to all local Nomads to supply the names of worthy individuals in European countries who might be made the recipients of merchandise packages. The chapter is pledged to send 75 such packages and Reinhold would appreciate the names of Europeans who have visited California, and who may now be having difficulty in subsisting under the difficult conditions now obtaining across the pond.

Graham Moody discusses finding costs

A frequent, capable, and always pleasing expositor on the petroleum circuit out California way is Graham Moody, Standard of Cal's economic geologist or geological economist, or whatever this popular critical analyst may be termed. In any case, he possesses in rare degree the faculty of presenting highly technical data in sugar coating, so that even those who are not too intimately conversant with the subject under discussion can appreciate and enjoy his offerings.

One of his most recent confections was a sort of tongue-in-cheek discussion of the relative cost of finding oil in California, prepared for the especial delectation of that polysyllabic brigade, the AAPG, at its annual meeting in Pasadena. In this lively opus, Maestro Moody pointed out that the process of determining finding cost is a matter of dividing the *total* exploratory expense by the *total* number of barrels of hydrocarbons discovered, which is simple enough until one attempts to define the pertinent factors.

The formula that he had worked out by his staff, using every known variable, and which he projected at the Pasadena caucus for all to see and admire, even if they couldn't understand, is just slightly shorter than the Trans-Arabian pipe line, and contains so many intergrations that it ought to include one more—D_{TSE}—representing the time required to effect its own solution.

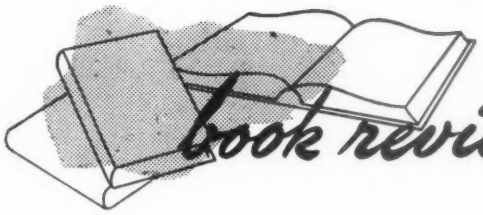
Particularly amusing in the discussion of these variables was the story of the geologist who had been notably inarticulate, and after 20 years with his organization had never once made a favorable recommendation. At last, however, he was so impressed by a particular prospect that he strongly urged the drilling of two wells on it. The management was so astonished by this unusual ardor that two wells were scheduled, and were drilled promptly—and simultaneously. They were drier than an oil man on his way to a convention and the poor geologist was summarily fired. When he had sufficiently recovered from the shock, he hastened to his boss, made abject apology for his poor judgment, and promised that if his job were given back to him, he would never make a favorable recommendation again.

In spite of the humor with which the Moody presentations are interspersed, however, they always have a liberal content of informative and provocative material, and this foray into the matter of finding costs was no exception. It drew attention to wide disparities in the relative finding costs of a number of oil operators, and debated at some length the causes of the differences. It exhorted the various finding groups to the utmost in cooperative effort, and ended with the expressed belief that the correct approach "backed by an exploration program based on a comprehensive analysis of all data, is mostly likely to find oil at reasonable cost in the future."

Dowell forms export department

Dowell Incorporated through its general sales manager, R. D. Shaw, announces the formation of a foreign sales and export department to be located in Tulsa at the company's general offices. The increasing foreign interest in Dowell's products and services and Dowell's expanding interest in its Venezuelan associate, United Oilwell Service S. A., have made necessary the new department, according to Shaw.

The management of the new department will be the responsibility of P. E. Fitzgerald who has been associated with Dowell for 15 years in various capacities including brief assignments in Canada, Mexico, and Venezuela and for more than 10 years the company's geologist. He will continue in this capacity and will also retain his membership on the board of United Oilwell Service.



● **Industrial Experimentation,** *by K. A. Brownlee. Chemical Publishing Company, 26 Court Street, Brooklyn, New York. Pages, 151. Price, $3.75.*

This is a guide to both the planning and the interpretation of experiments on the industrial scale, and is primarily concerned with pilot plant and plant scale experiments on chemical manufacturing process.

In order to apply tests of significance conveniently and economically the experiments must be planned with a statistician, or with due regard to the statistical principles involved. The statistical methods presented have long proved to be of great value in other fields of experimentation, notably agriculture. Those who must apply critical tests of statistical significance in practice will find this volume particularly useful.

● **Reference Report on Certain Oil and Gas Fields of North Louisiana, South Arkansas, Mississippi and Alabama, 1945.** *Shreveport Geological Society, Box 750, Shreveport, Louisiana. Volume I: Pages, 328. Price, $12.50. Volume II: Pages, 204. Price, $10.*

Volume I. Over two years of work went into this thorough report on the oil and gas fields of North Louisiana, South Arkansas, Mississippi and Alabama. The first volume includes sixty fields and three stratigraphic sections. Each field is illustrated with a stratigraphic chart and a structural contour map. The location, pre-discovery data and discovery wells, with their producing zones, are given. The development of each field, its proven area and production data to date are presented in the individual field studies. Allowable, pipe line outlets, and miscellaneous data also are combined for a clear picture.

Volume II. This volume contains twenty-five fields, nine stratigraphic sections and a paper dealing with the stratigraphy of the Cretaceous of East Texas, Southern Arkansas, Northern Louisiana, Mississippi and Alabama. A bibliography of oil and gas fields is included. The Shreveport Geological Society has greatly furthered knowledge of the Upper Gulf Coast area with this outstanding report.

● **Land Measures,** *by J. Roy Reasonover. P. O. Box 1746, Houston, Texas. Pages, 124. Price, $5.*

An active member of a land department, Mr. Reasonover saw the need for assembled information on land measures and quantities. In this book, he clarifies the systems by which tracts of land are described and bounded. French, Spanish and English land measures of the United States and Canada with units, English equivalents, reduction and conversion factors answer questions, and aid in decisions and transactions which assail lawyers, land surveyors, engineers, oil companies, architects, and others who need a handy reference on facts of land measures.

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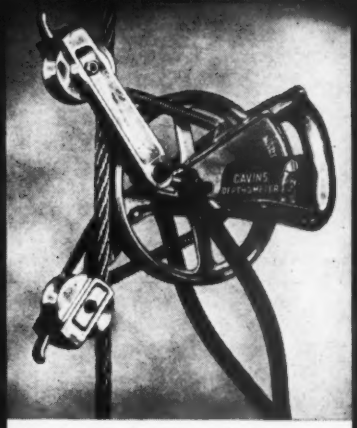

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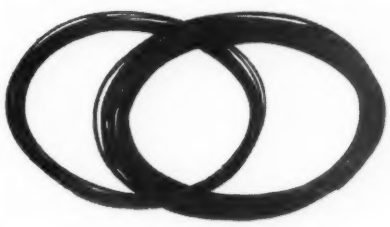

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